

Supporting information

Design, Synthesis, and Fungicidal Activity of Novel Thiosemicarbazide Derivatives Containing Piperidine Fragments

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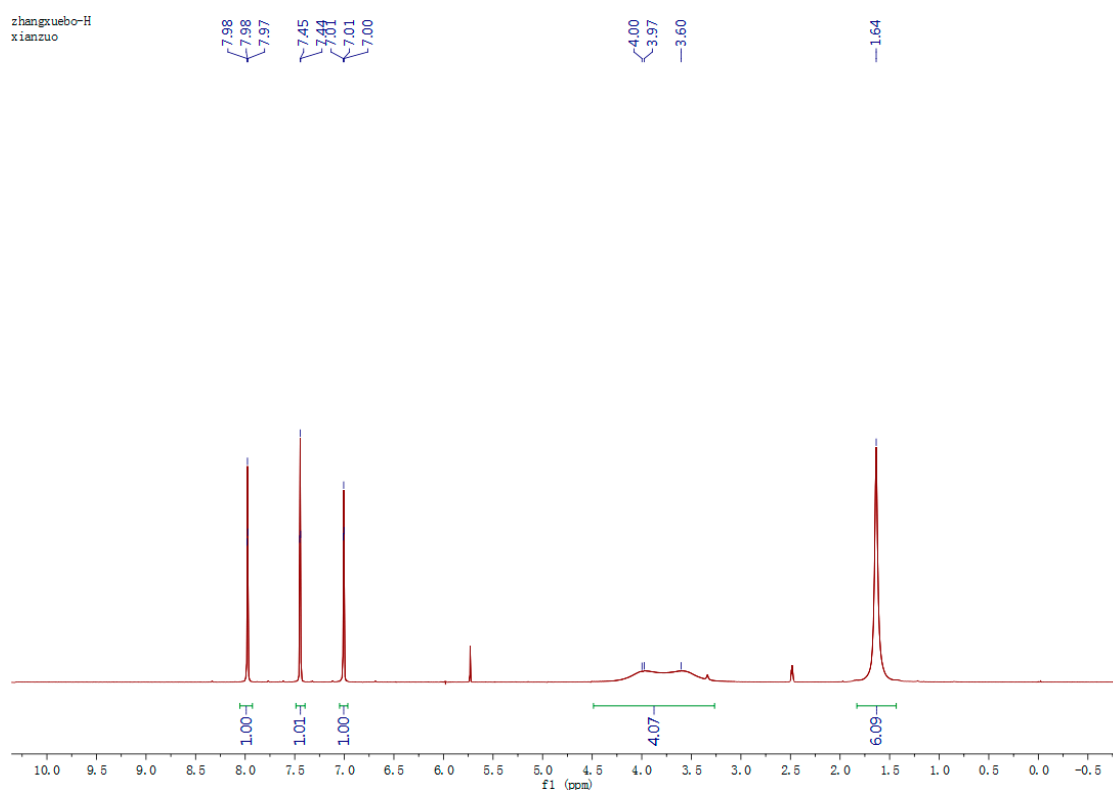


Figure S1. ¹H-NMR spectra of the intermediate compound (1H-imidazol-1-yl)(piperidin-1-yl)methanethione (**1a**).

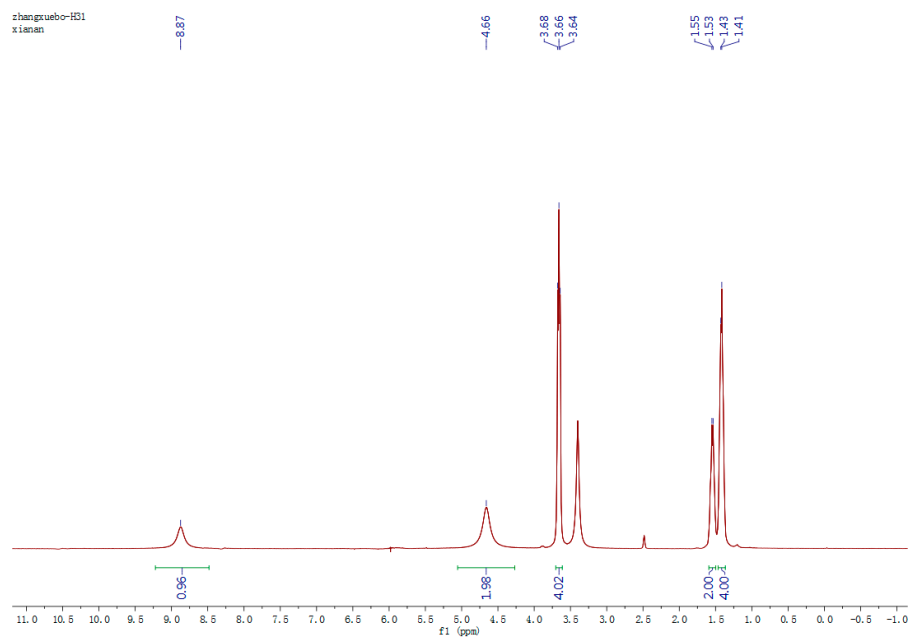


Figure S2. ^1H -NMR spectra of the intermediate compound piperidine-1-carbothiohydrazide (**2a**).

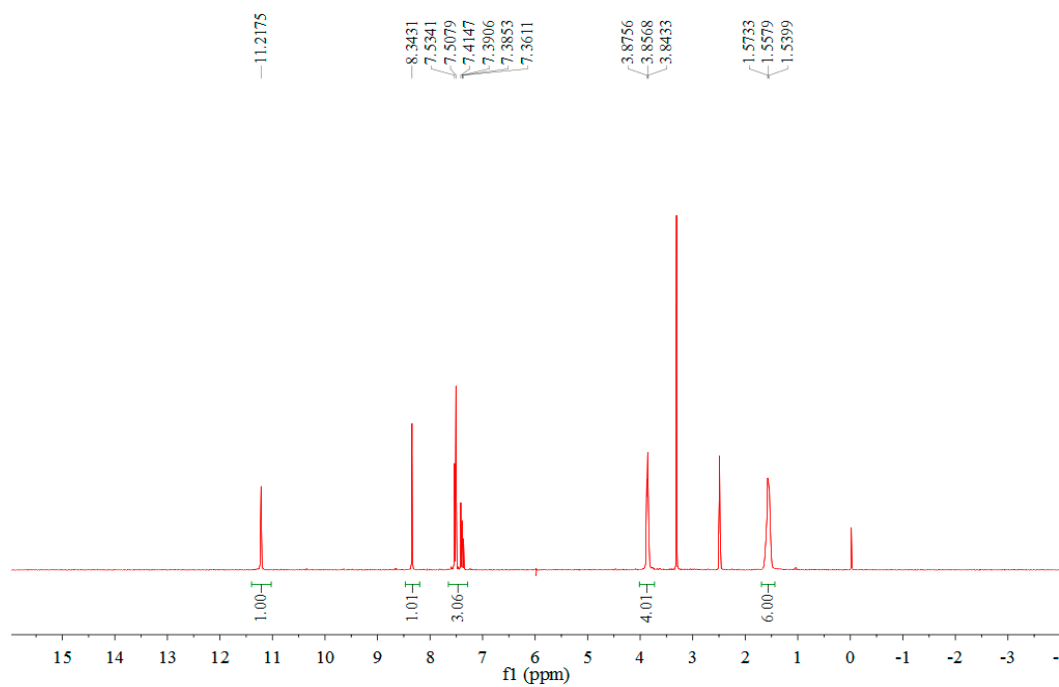


Figure S3. ^1H -NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)piperidine-1-carbothiohydrazide (**3a**).

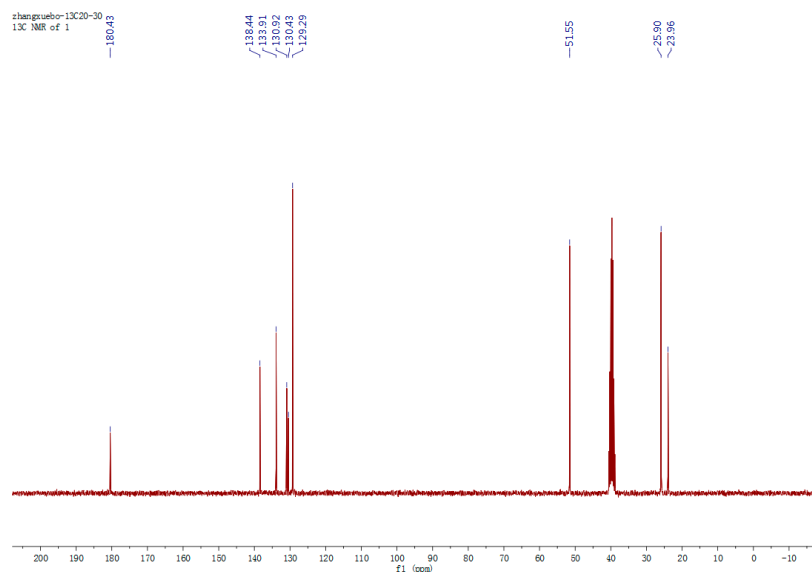


Figure S4. ^{13}C -NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)piperidine-1- carbothiohydrazide (**3a**).

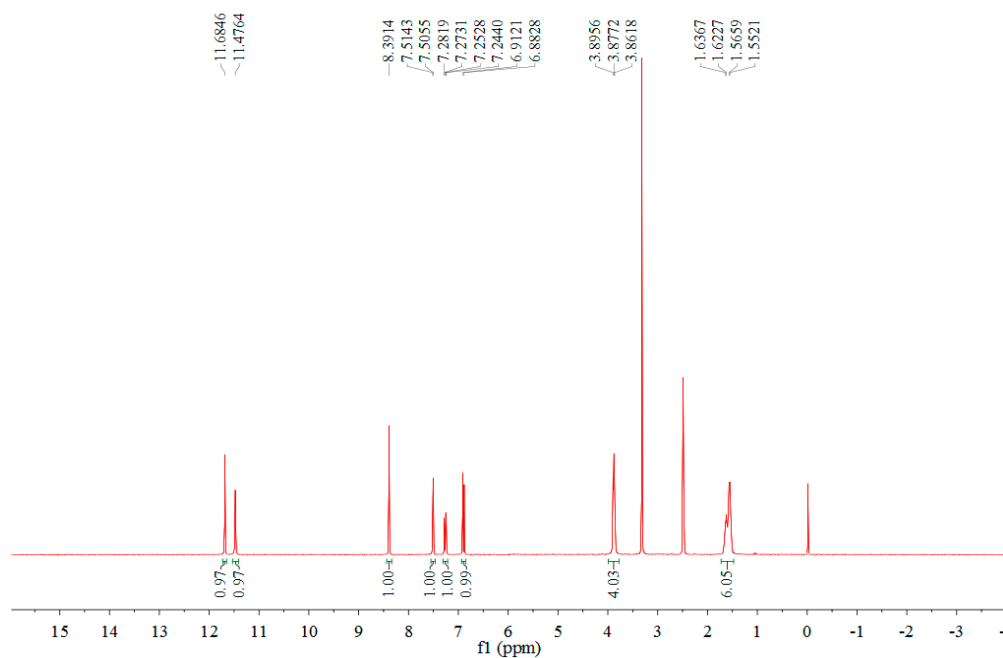


Figure S5. ^1H NMR spectra of the title compound (*E*)-*N'*-(5-chloro-2-hydroxybenzylidene)piperidine-1- carbothiohydrazide (**3b**)

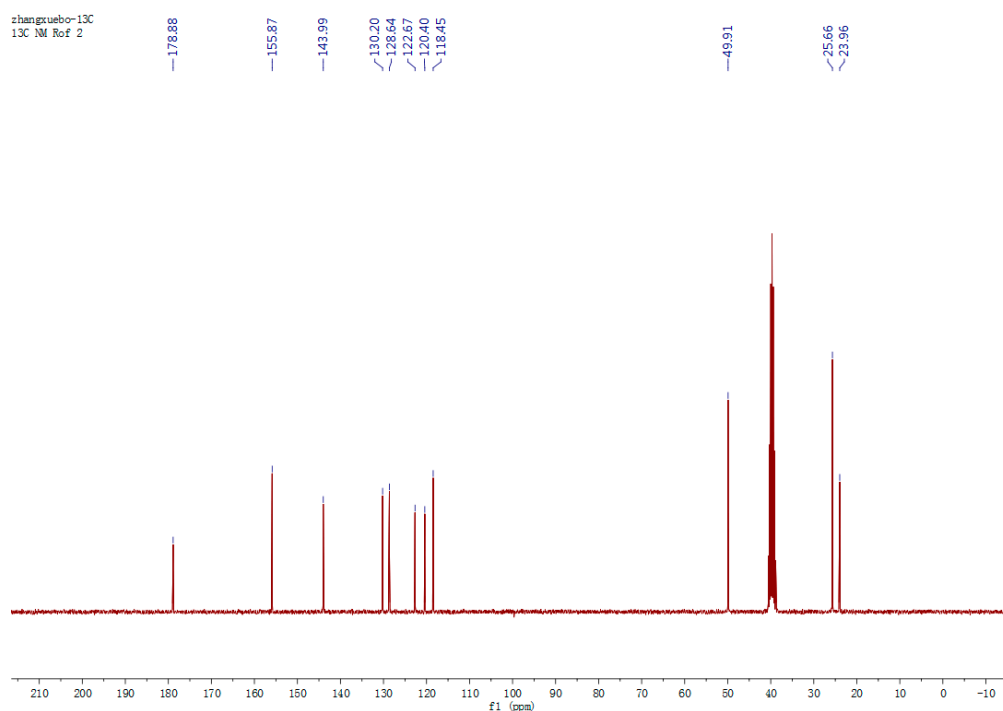


Figure S6. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(5-chloro-2-hydroxybenzylidene)piperidine-1-carbothiohydrazide (**3b**)

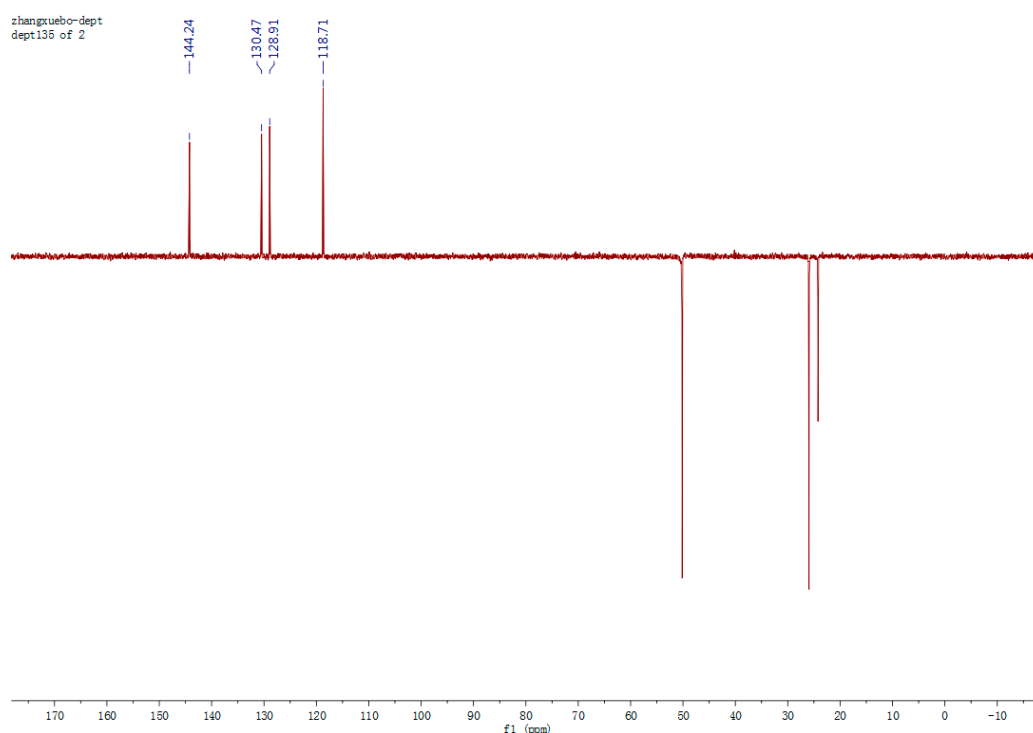


Figure S7. DEPT 135 spectra of the title compound *(E)*-*N'*-(5-chloro-2-hydroxybenzylidene)piperidine-1-carbothiohydrazide (**3b**)

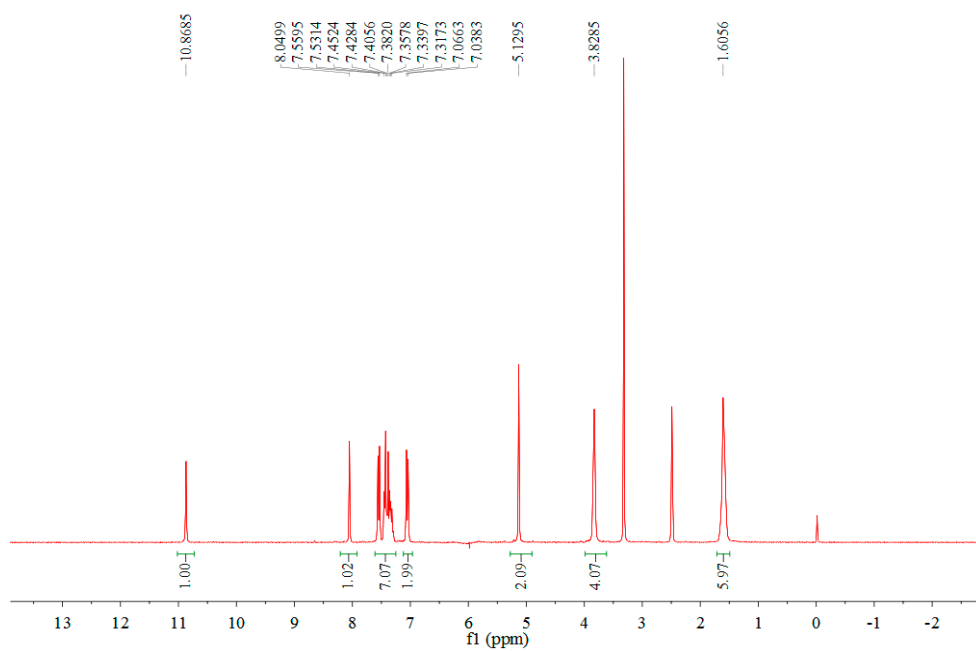


Figure S8. ¹H NMR spectra of the title compound (E)-N'-(4-(benzyloxy)benzylidene)piperidine-1-carbothiohydrazide (3c)

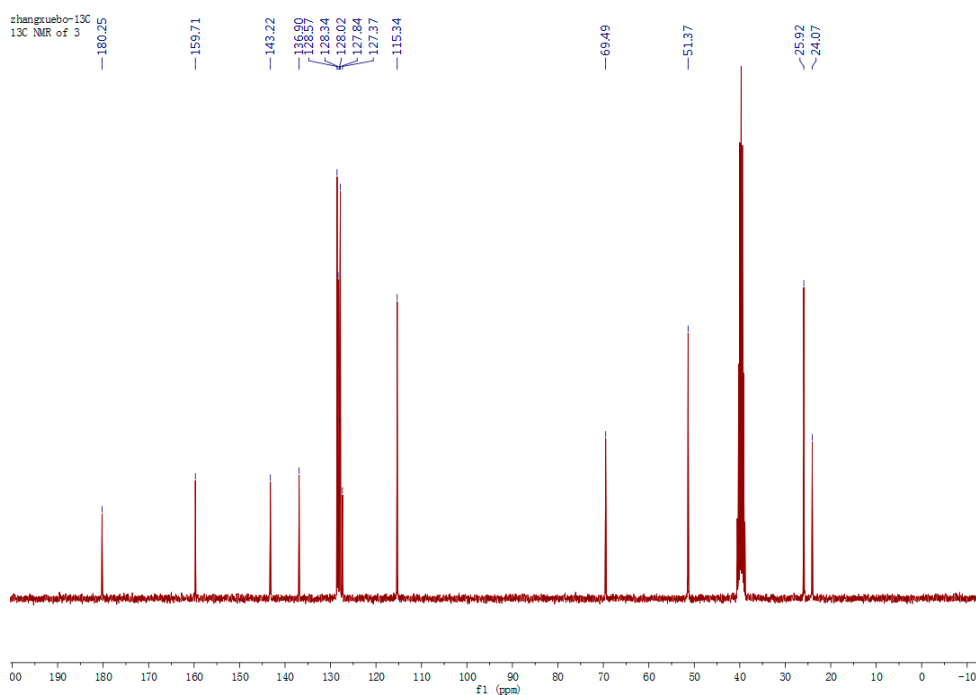


Figure S9. ¹³C NMR spectra of the title compound (E)-N'-(4-(benzyloxy)benzylidene)piperidine-1-carbothiohydrazide (3c)

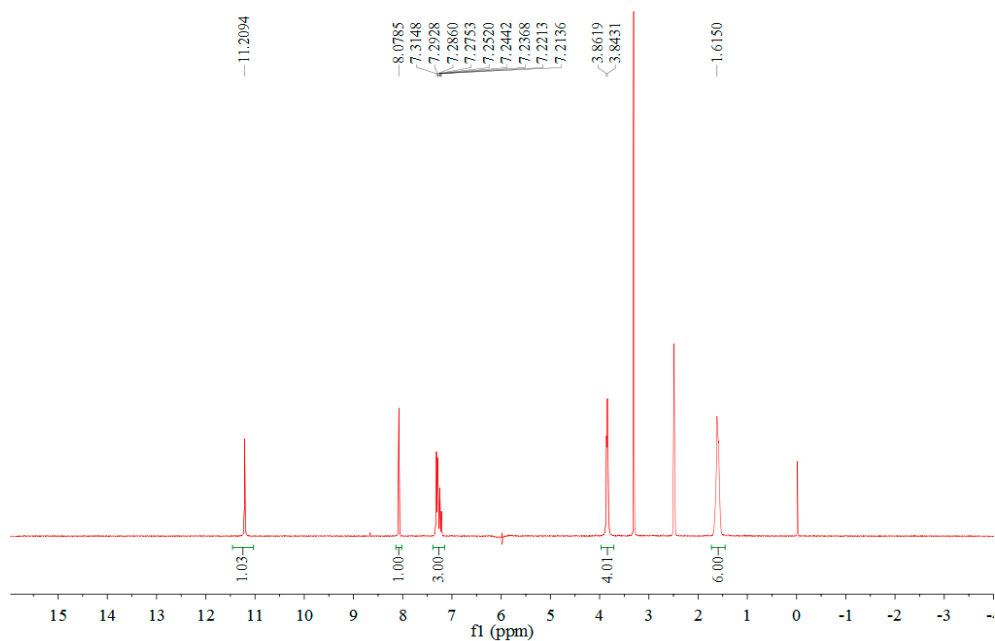


Figure S10. ¹H NMR spectra of the title compound (*E*)-*N'*-(3,5-difluorobenzylidene)piperidine-1-carbothiohydrazide(3d)

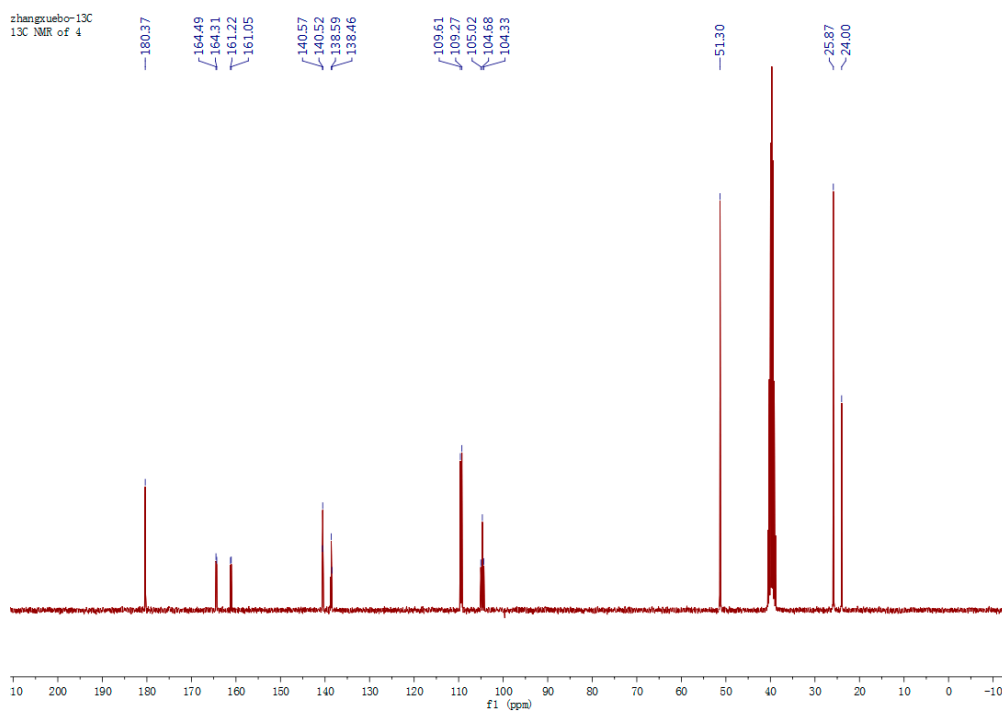


Figure S11. ¹³C NMR spectra of the title compound (*E*)-*N'*-(3,5-difluorobenzylidene)piperidine-1-carbothiohydrazide(3d).

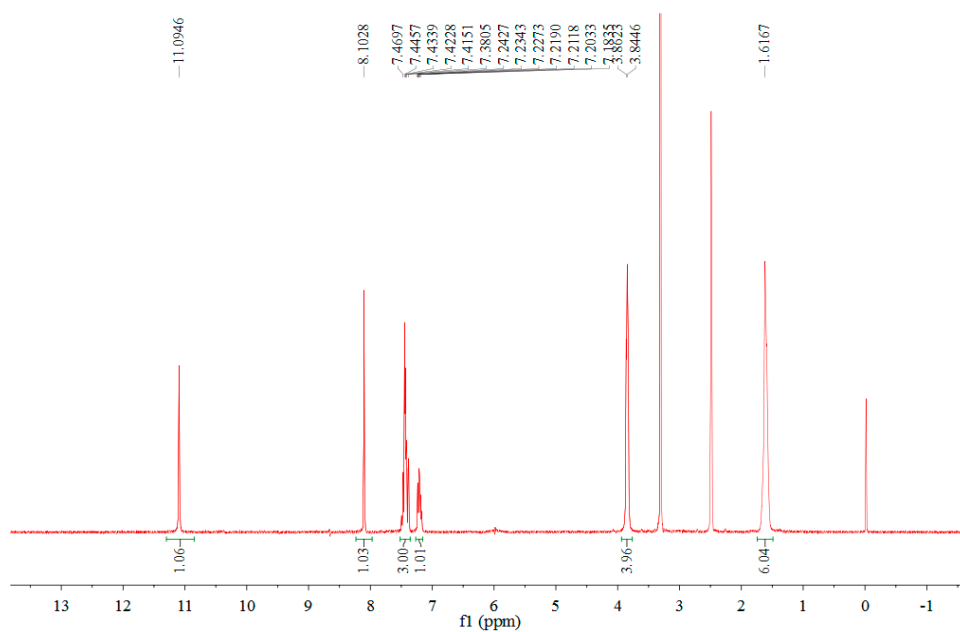


Figure S12. ¹H NMR spectra of the title compound (E)-N'-(3-fluorobenzylidene)piperidine-1-carbothiohydrazide (3e)

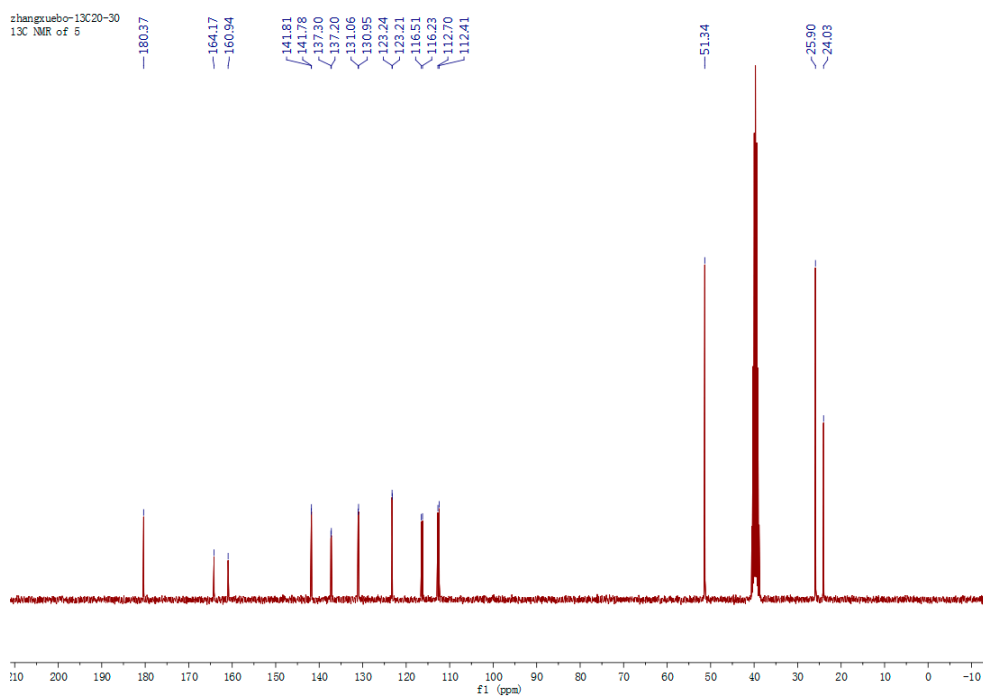


Figure S13. ¹³C NMR spectra of the title compound (E)-N'-(3-fluorobenzylidene)piperidine-1-carbothiohydrazide (3e)

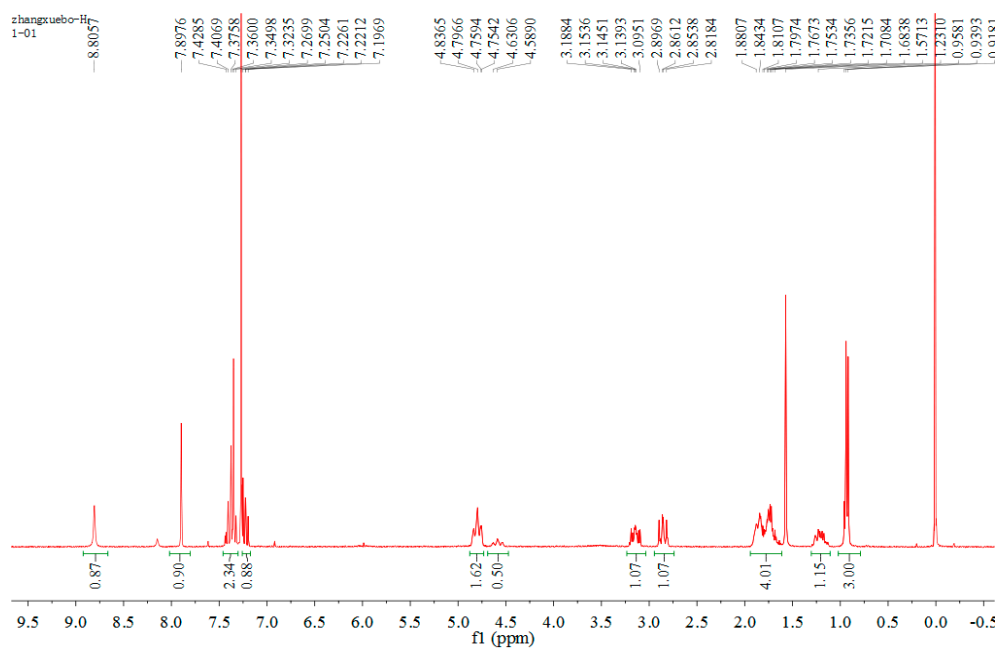


Figure S14. ^1H NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (3f)

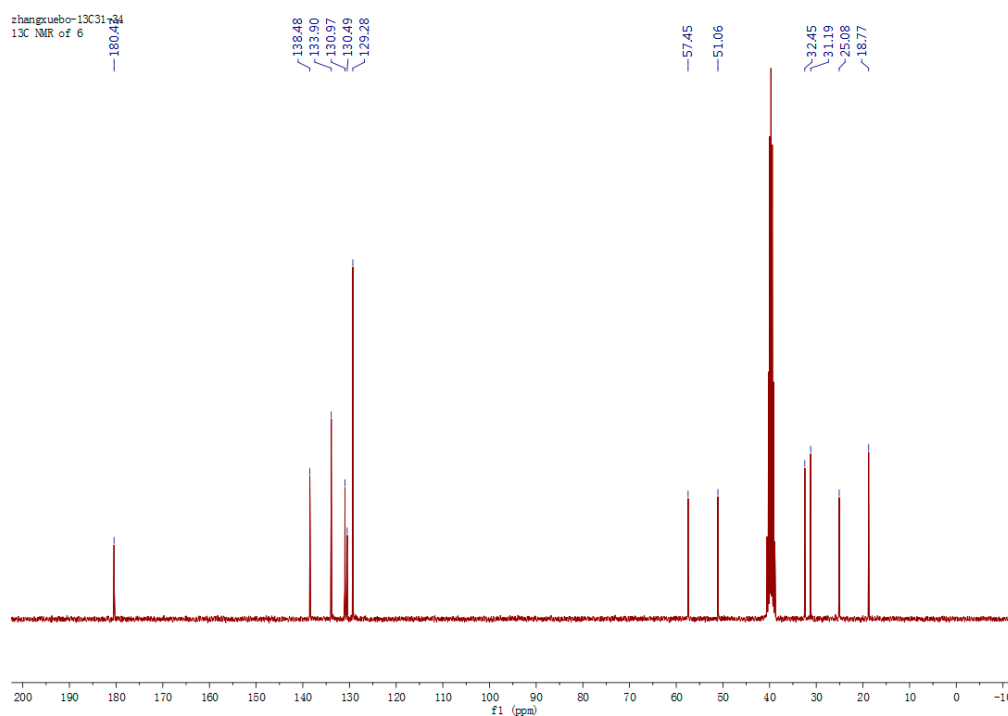


Figure S15. ^{13}C NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (3f)

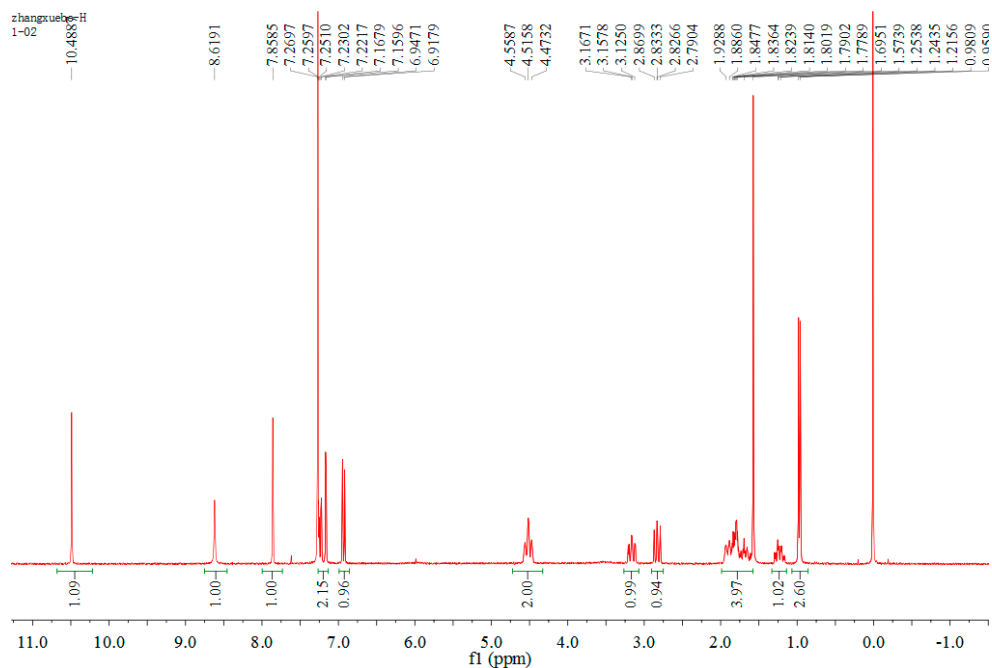


Figure S16. ^1H NMR spectra of the title compound *(E)*-*N'*-(5-chloro-2-hydroxybenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3g**)

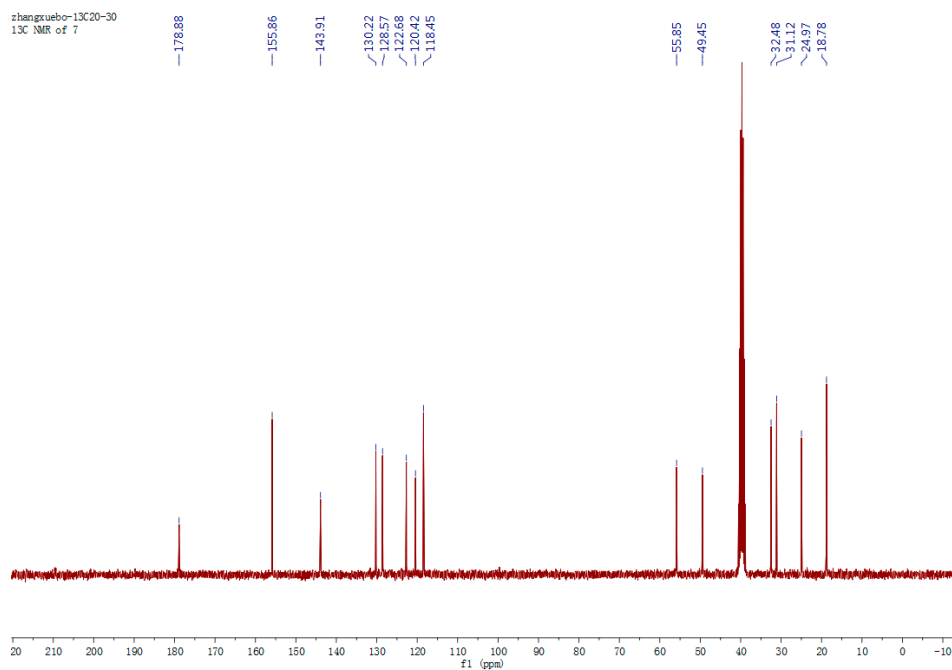


Figure S17. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(5-chloro-2-hydroxybenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3g**)

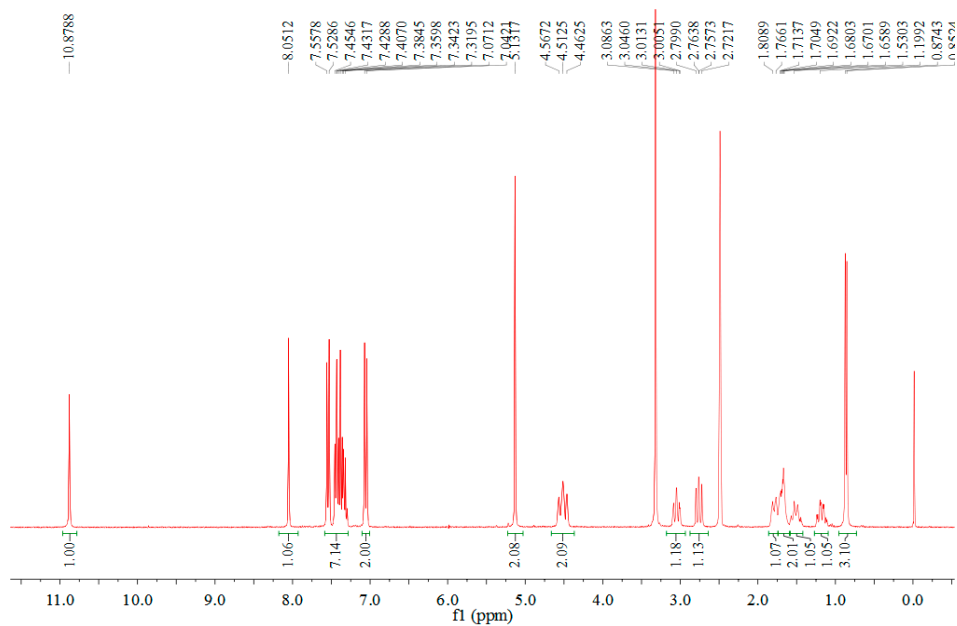


Figure S18. ^1H NMR spectra of the title compound *(E)*-*N'*-(4-(benzyloxy)benzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3h**)

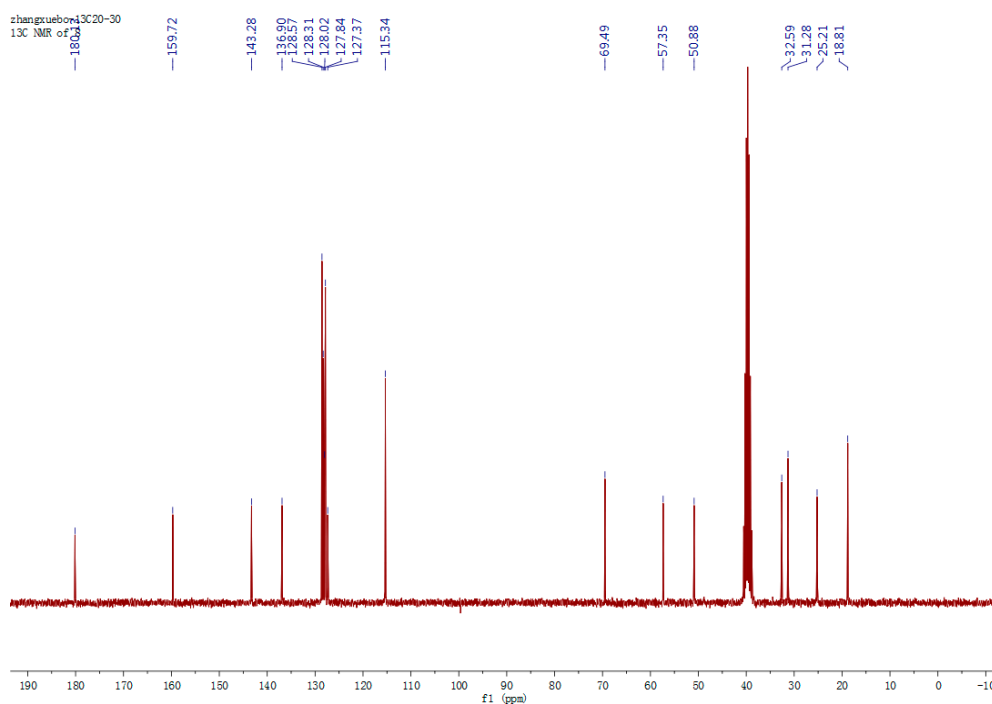


Figure S19. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(4-(benzyloxy)benzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3h**)

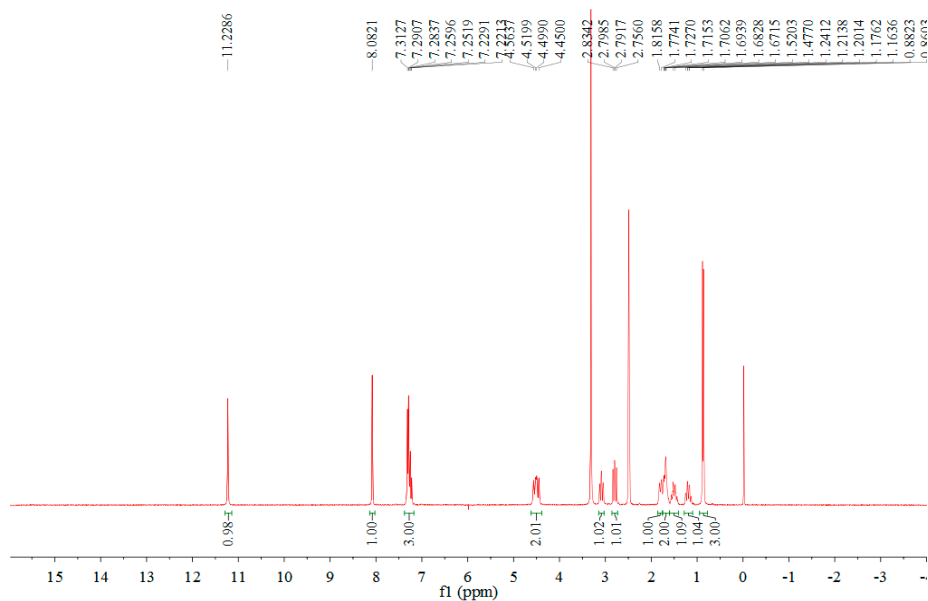


Figure S20. ^1H NMR spectra of the title compound *(E)*-*N'*-(3,5-difluorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3i**)

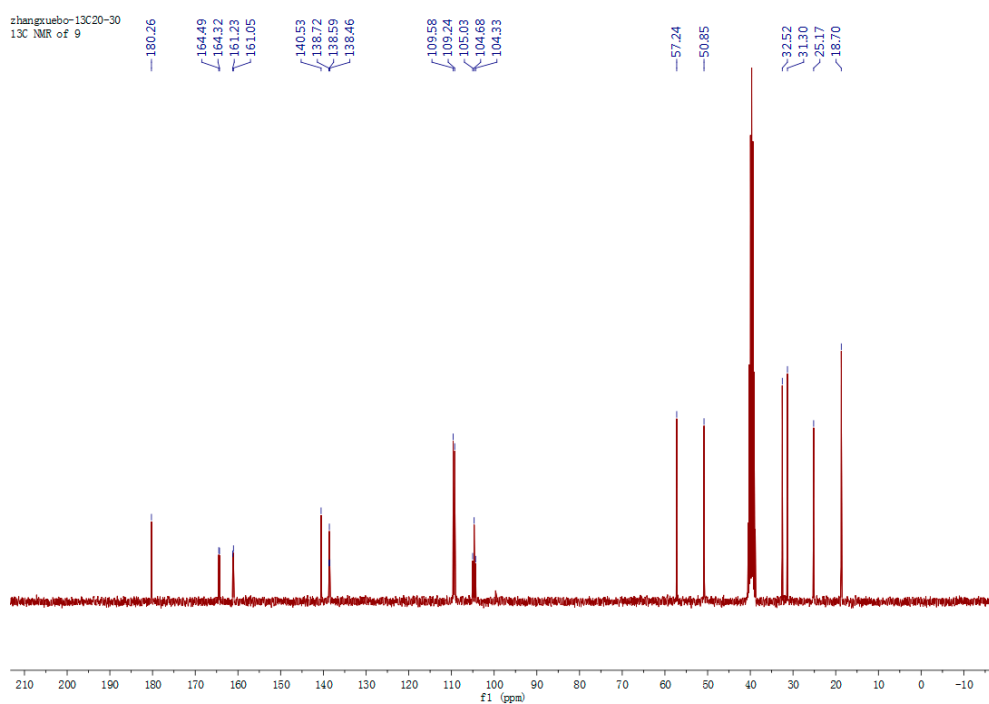


Figure S21. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(3,5-difluorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3i**)

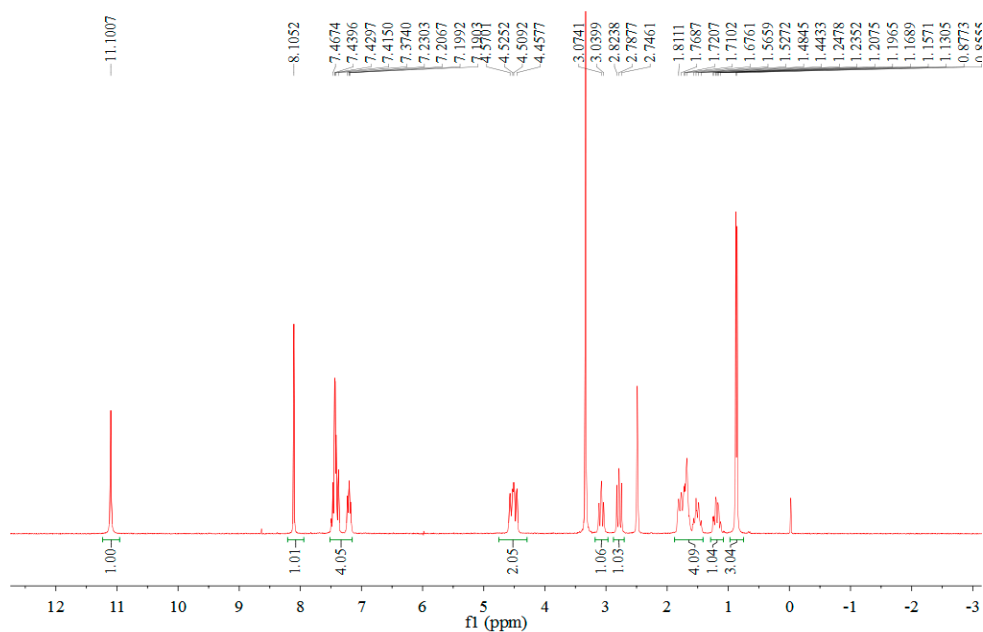


Figure S22. ^1H NMR spectra of the title compound *(E)*-*N'*-(3-fluorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3j**)

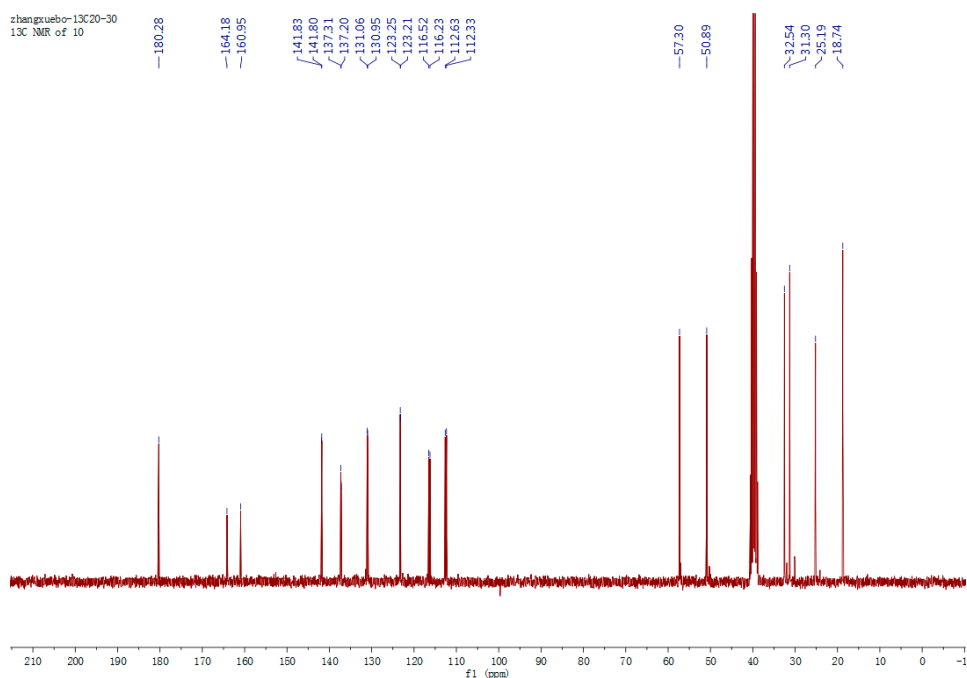


Figure S23. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(3-fluorobenzylidene)-3-methylpiperidine-1-carbothiohydrazide (**3j**)

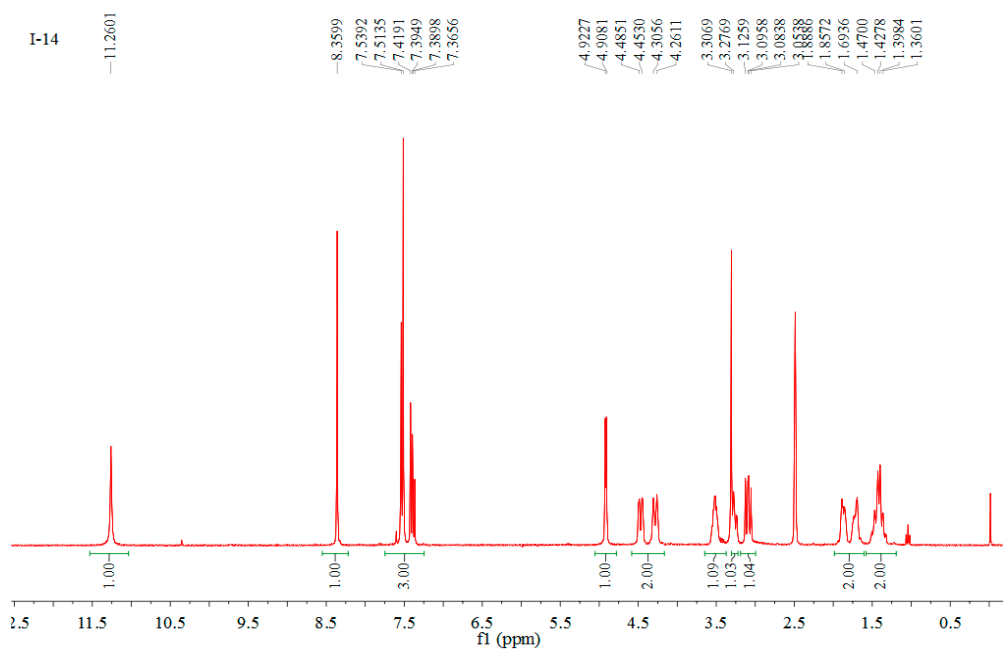


Figure S24. ^1H NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3k**)

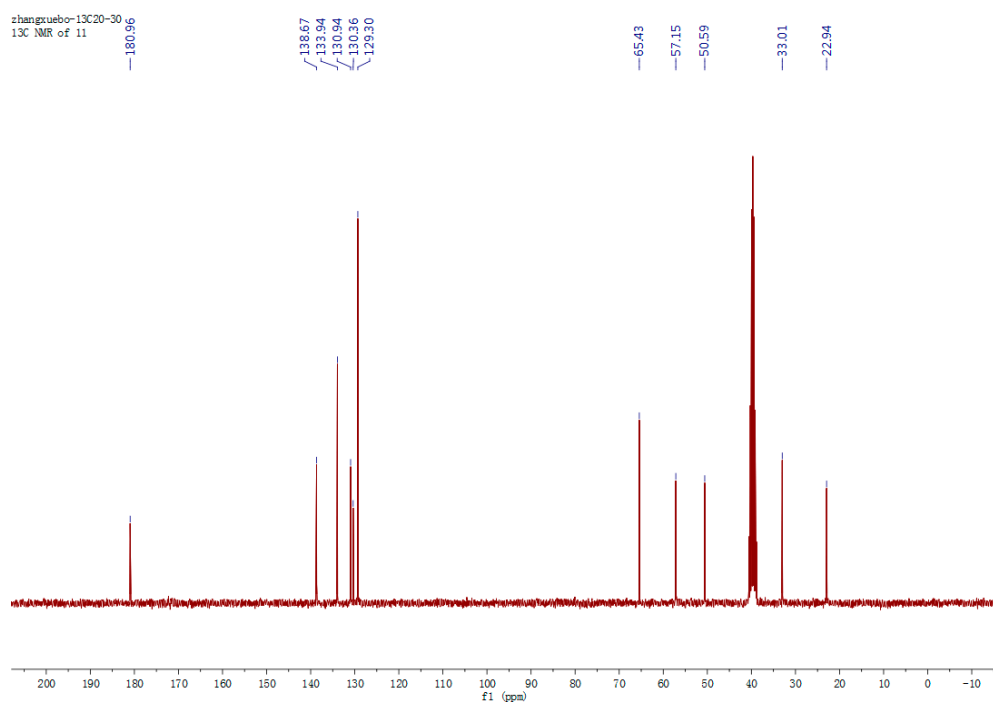


Figure S25. ^{13}C NMR spectra of the title compound (*E*)-*N'*-(2,6-dichlorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3k**)

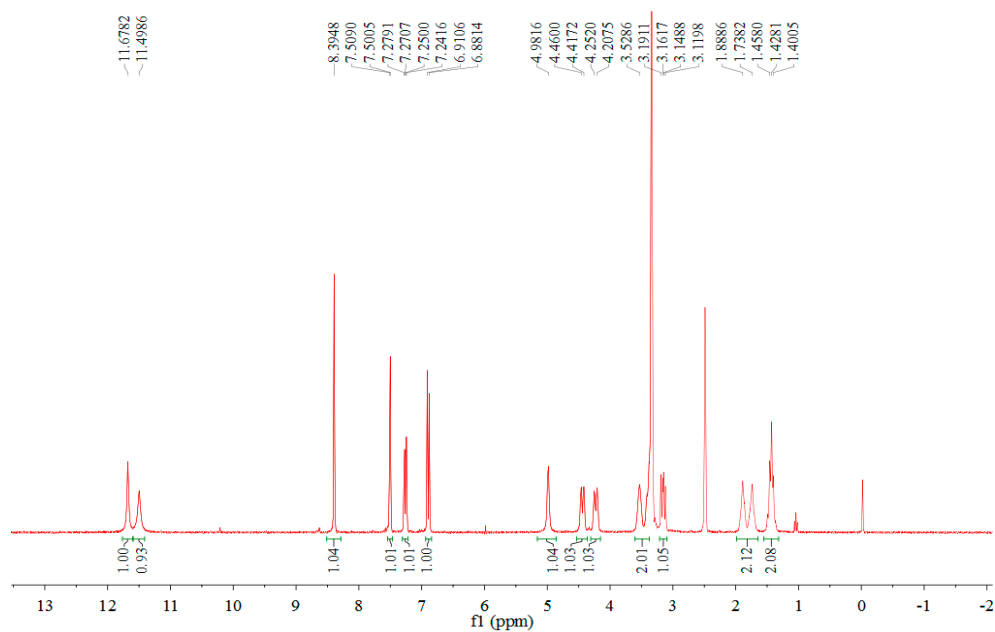


Figure S26. ¹H NMR spectra of the title compound (E)-N'-(5-chloro-2-hydroxybenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (3l)

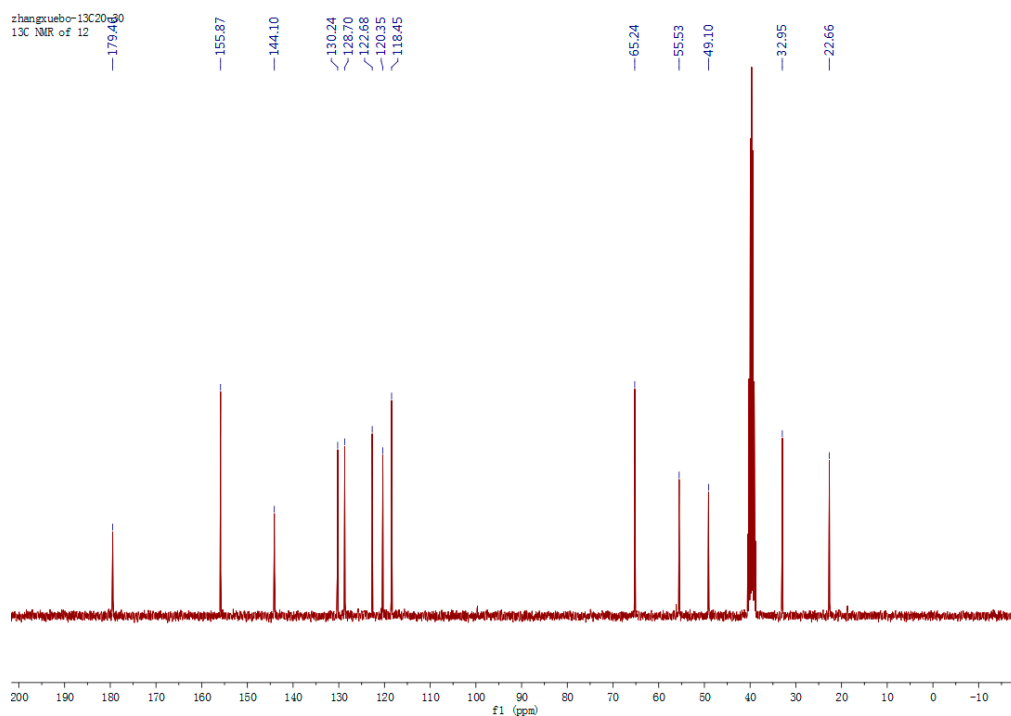


Figure S27. ¹³C NMR spectra of the title compound (E)-N'-(5-chloro-2-hydroxybenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (3l)

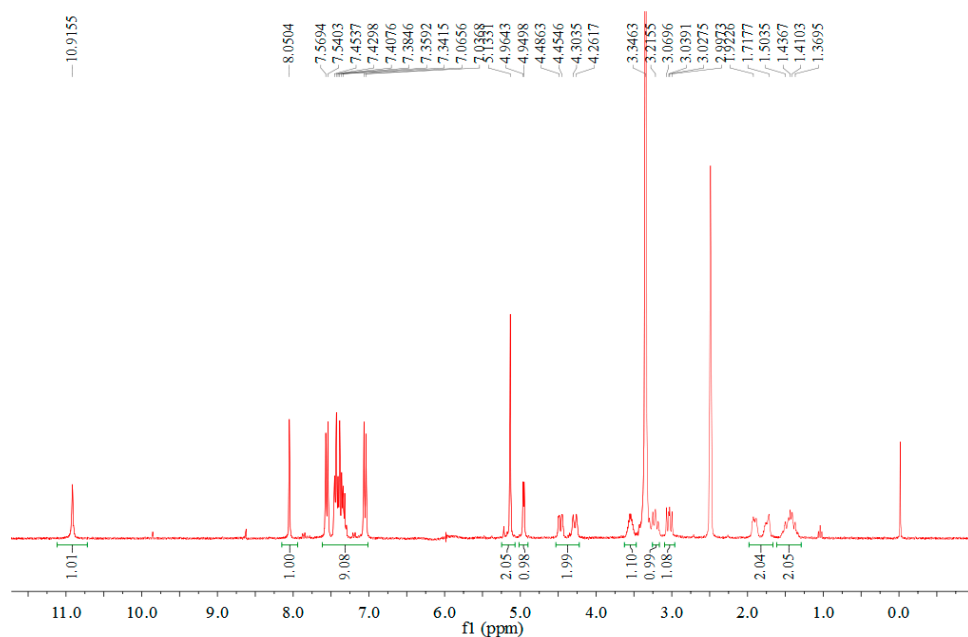


Figure S28. ^1H NMR spectra of the title compound *(E)*-*N'*-(4-(benzyloxy)benzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3m**)

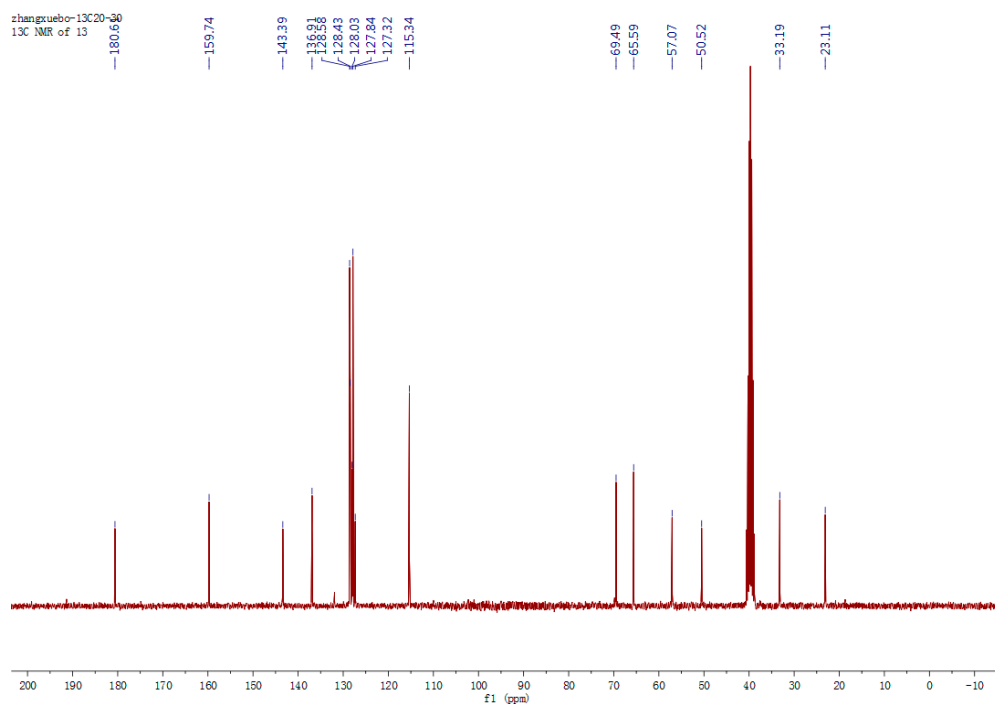


Figure S29. ^{13}C NMR spectra of the title compound *(E)*-*N'*-(4-(benzyloxy)benzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3m**)

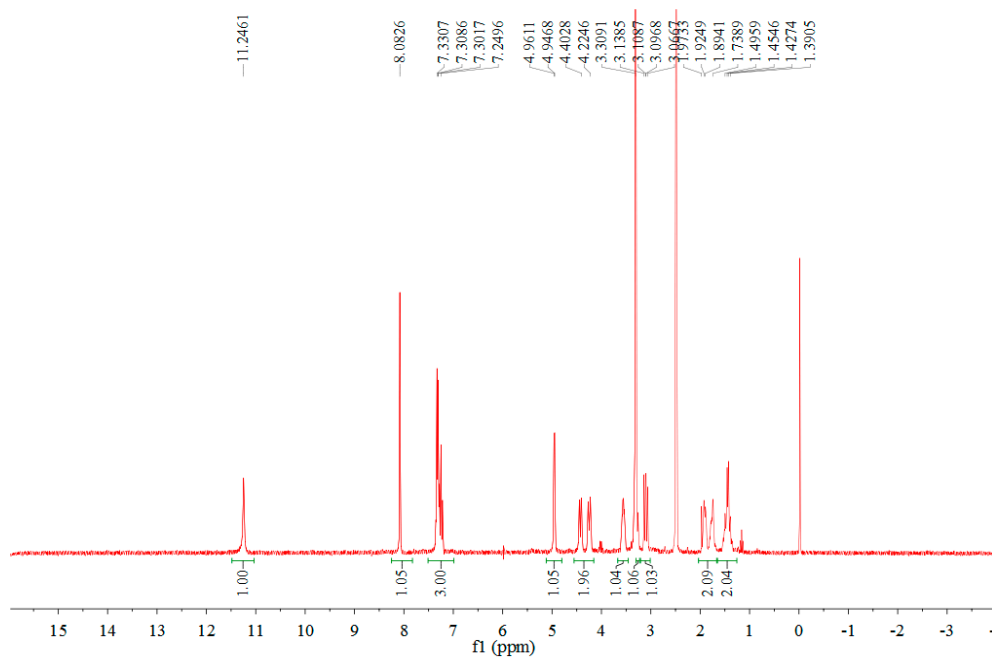


Figure S30. ¹H NMR spectra of the title compound (E)-N'-(3,5-difluorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (3n)

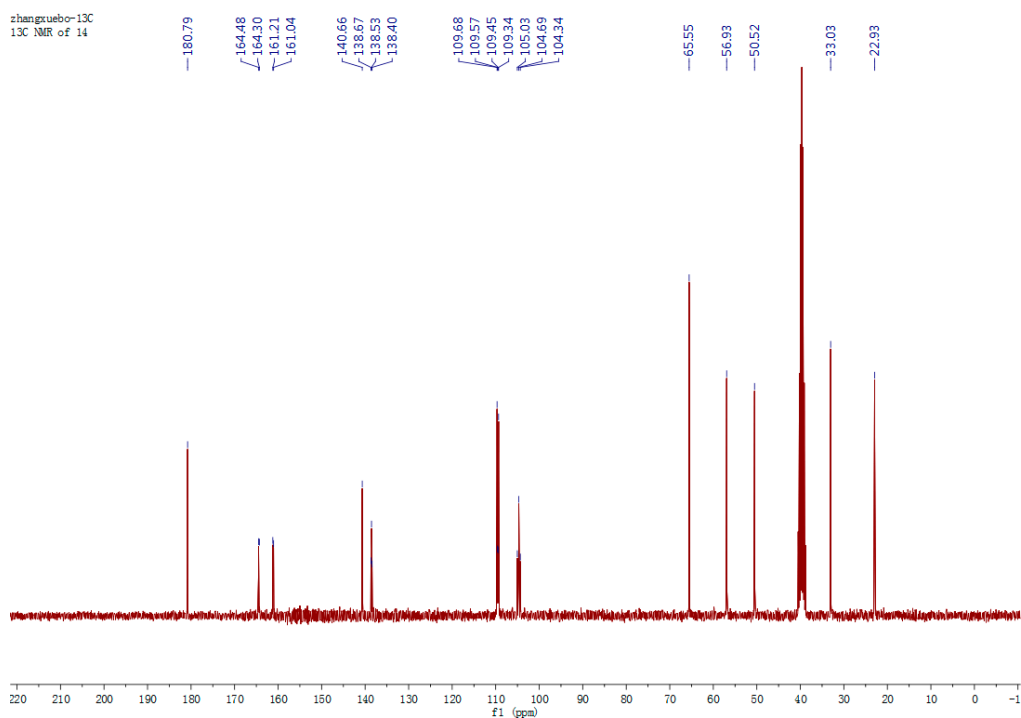


Figure S31. ¹³C NMR spectra of the title compound (E)-N'-(3,5-difluorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (3n)

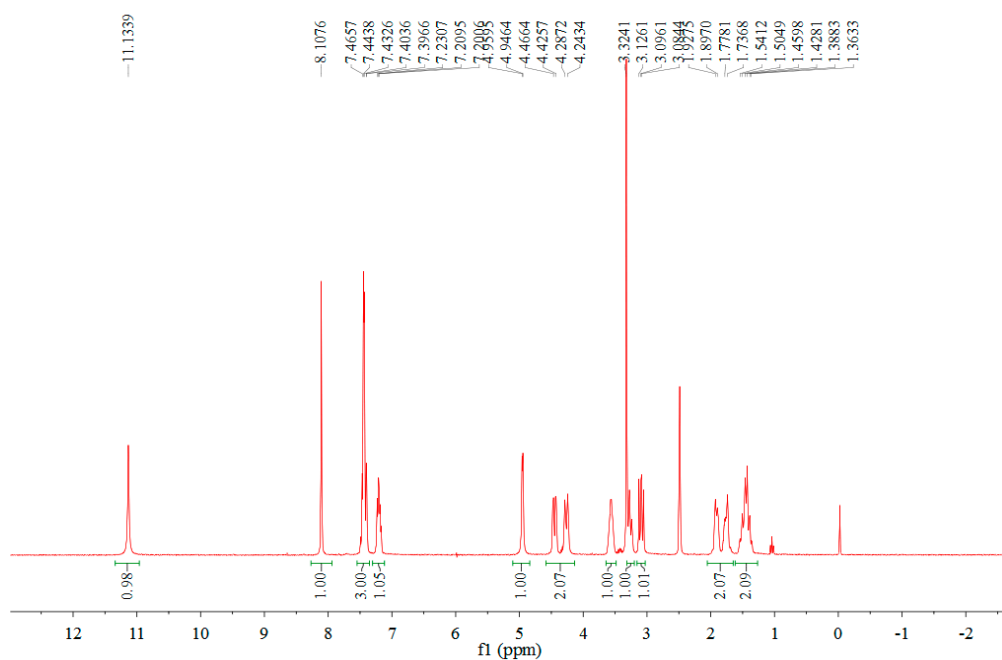


Figure S32. ^1H NMR spectra of the title compound (*E*)-*N'*-(3-fluorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3o**)

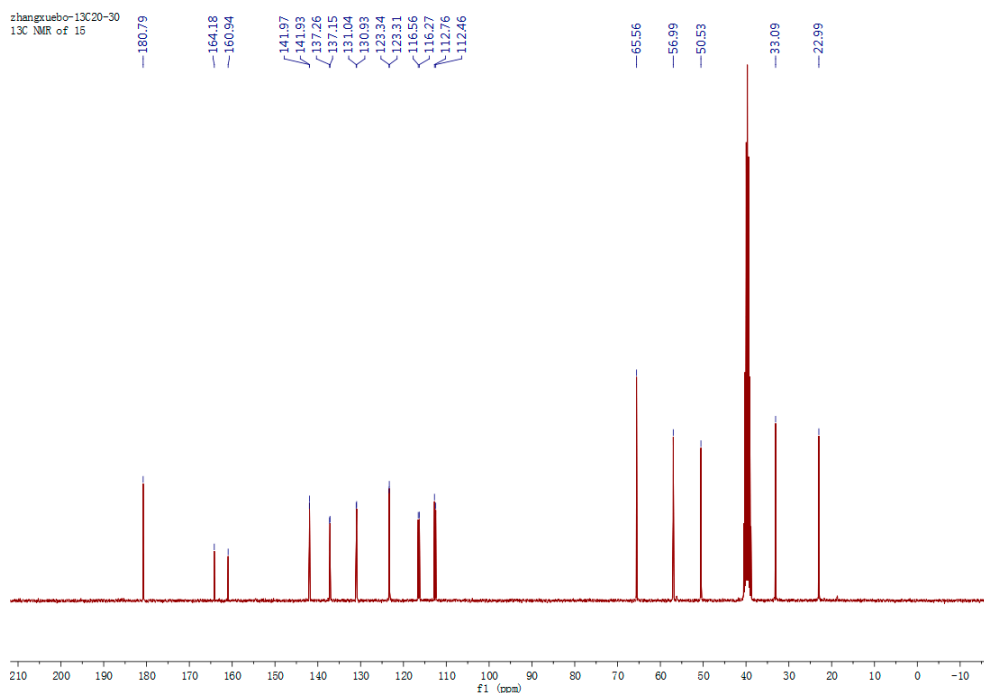


Figure S33. ^{13}C NMR spectra of the title compound (*E*)-*N'*-(3-fluorobenzylidene)-3-hydroxypiperidine-1-carbothiohydrazide (**3o**)

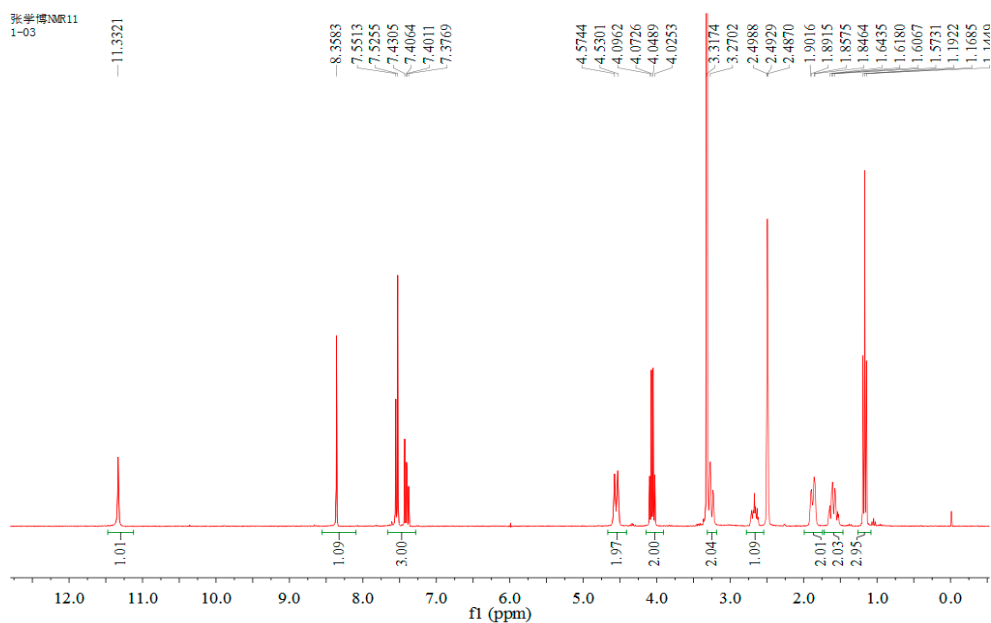


Figure S34. ^1H NMR spectra of the title compound **Ethyl (E)-1-(2-(2,6-dichlorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3p)**

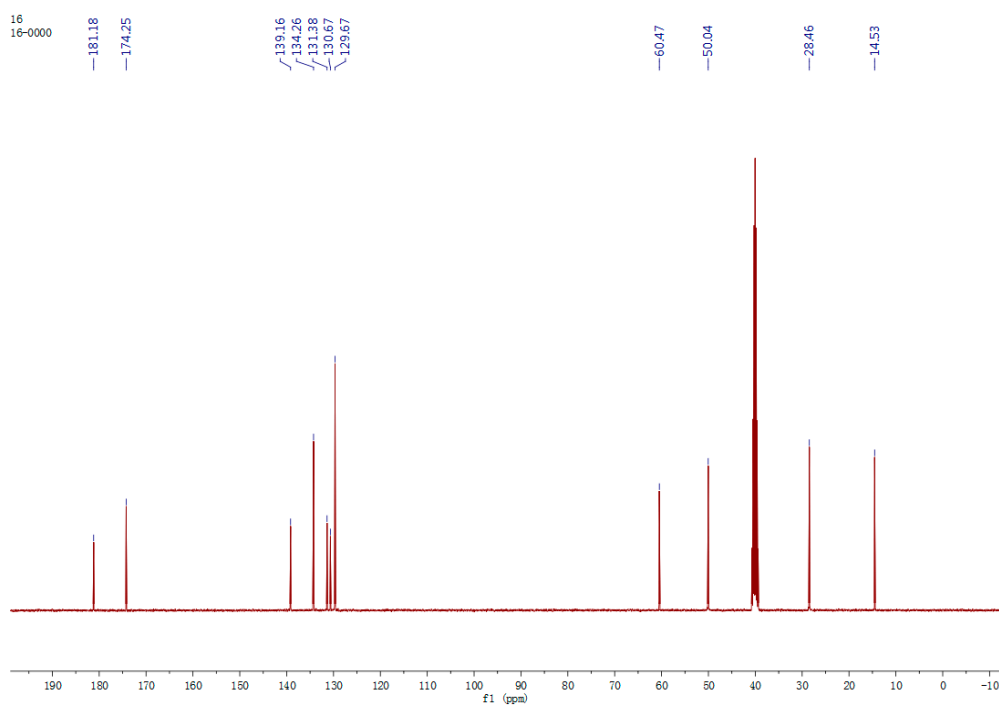


Figure S35. ^{13}C NMR spectra of the title compound **Ethyl (E)-1-(2-(2,6-dichlorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3p)**

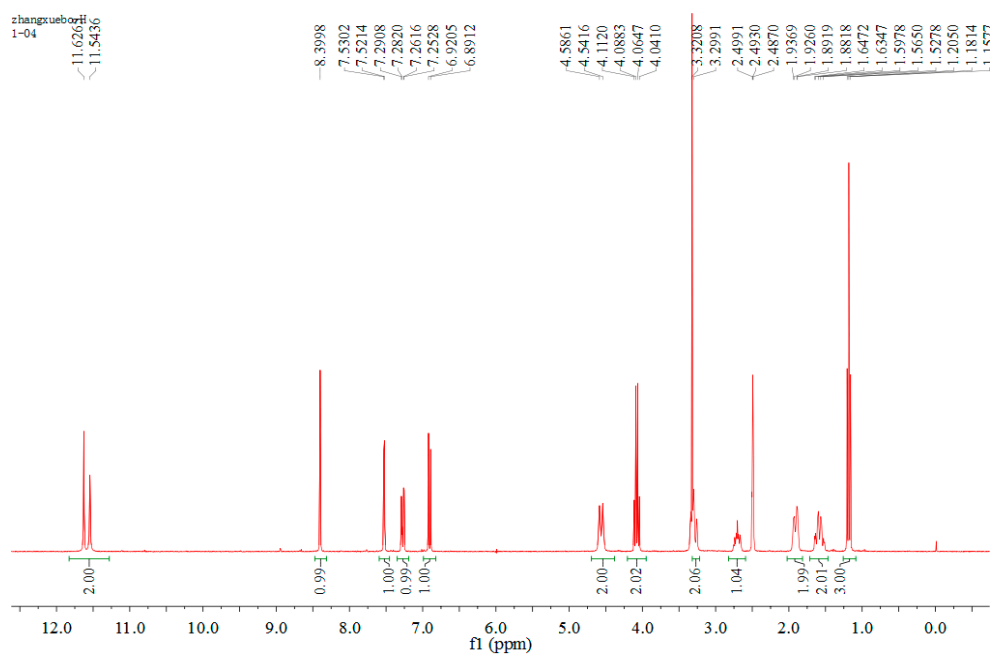


Figure S36. ^1H NMR spectra of the title compound **Ethyl (E)-1-(2-(5-chloro-2-hydroxybenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3q)**

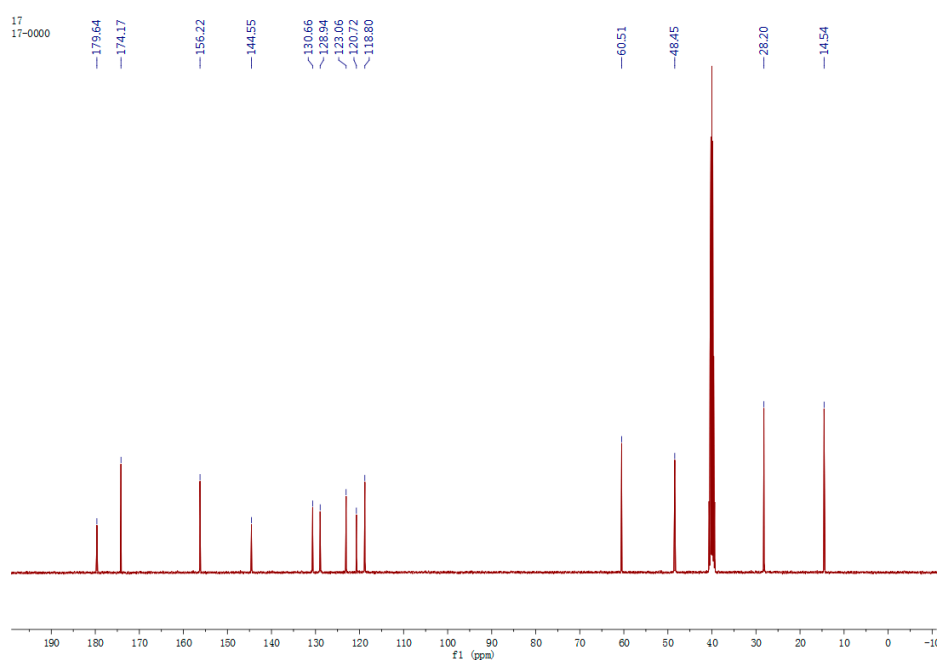


Figure S37. ^{13}C NMR spectra of the title compound **Ethyl (E)-1-(2-(5-chloro-2-hydroxybenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3q)**

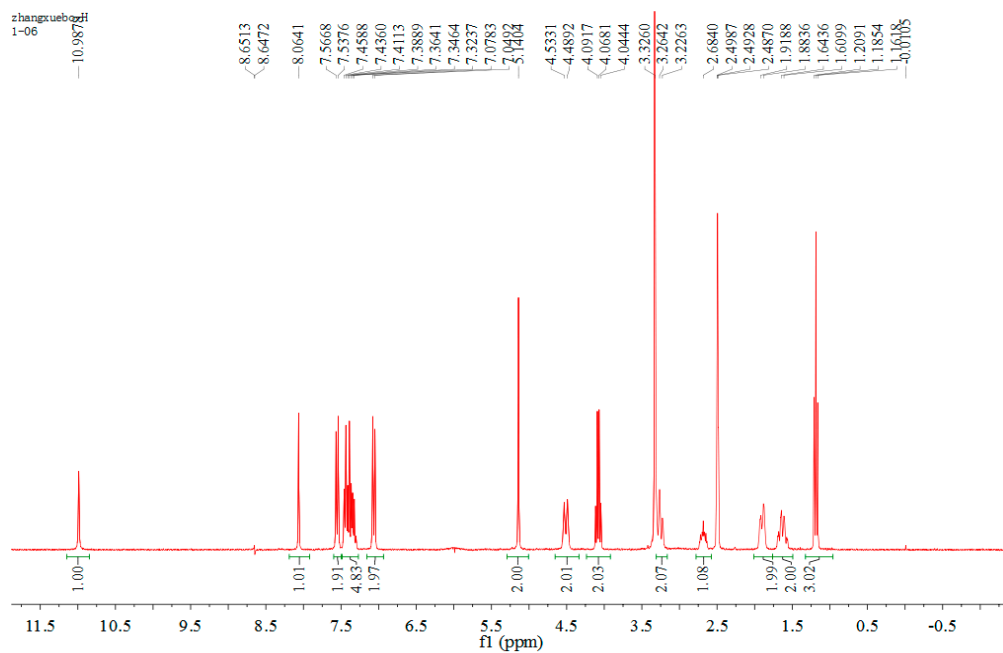


Figure S38. ^1H NMR spectra of the title compound Ethyl (E)-1-(2-(4-(benzyloxy)benzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3r)

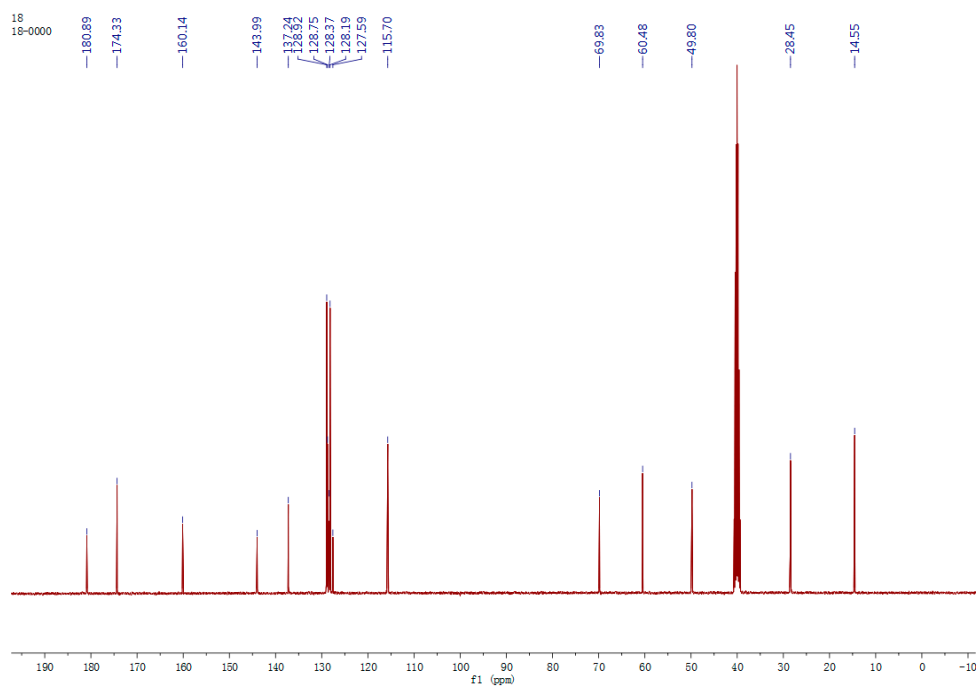


Figure S39. ^{13}C NMR spectra of the title compound Ethyl (E)-1-(2-(4-(benzyloxy)benzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3r)

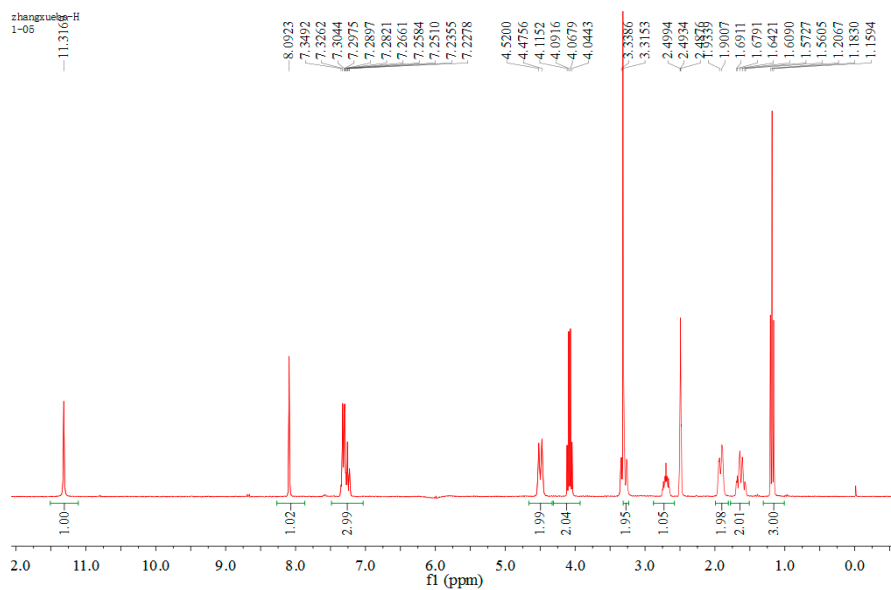


Figure S40. ^1H NMR spectra of the title compound **Ethyl (E)-1-(2-(3,5-difluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3s)**

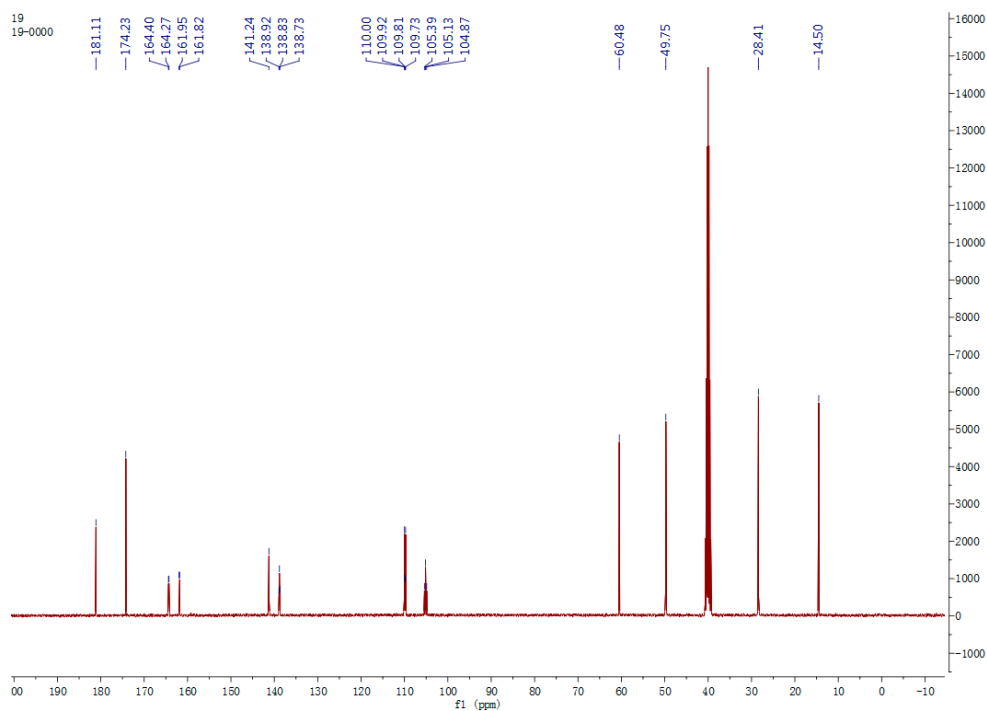


Figure S41. ^{13}C NMR spectra of the title compound **Ethyl (E)-1-(2-(3,5-difluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3s)**

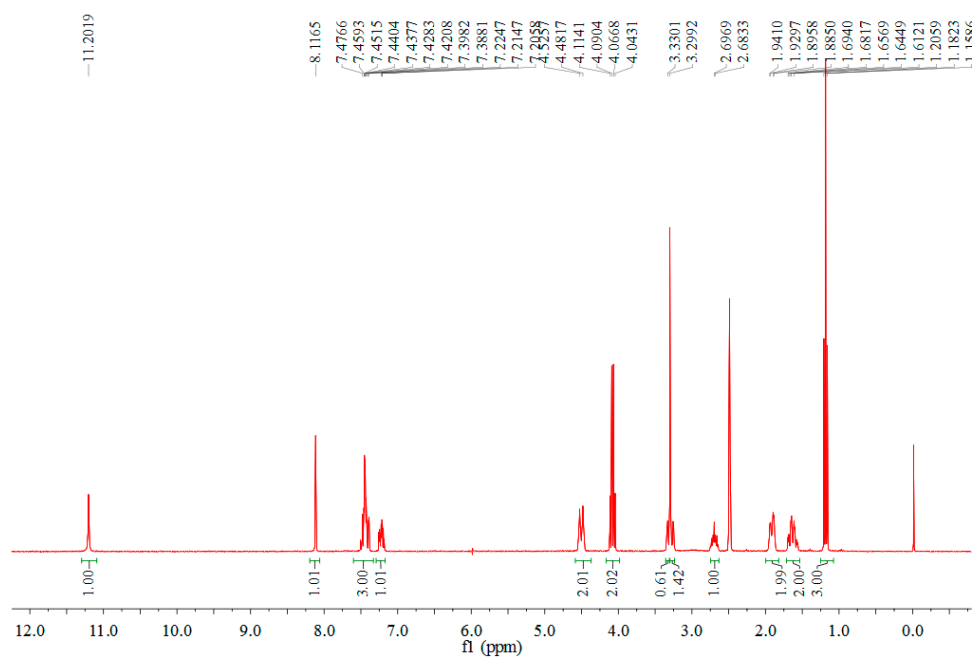


Figure S42. ^1H NMR spectra of the title compound **Ethyl (E)-1-(2-(3-fluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3t)**

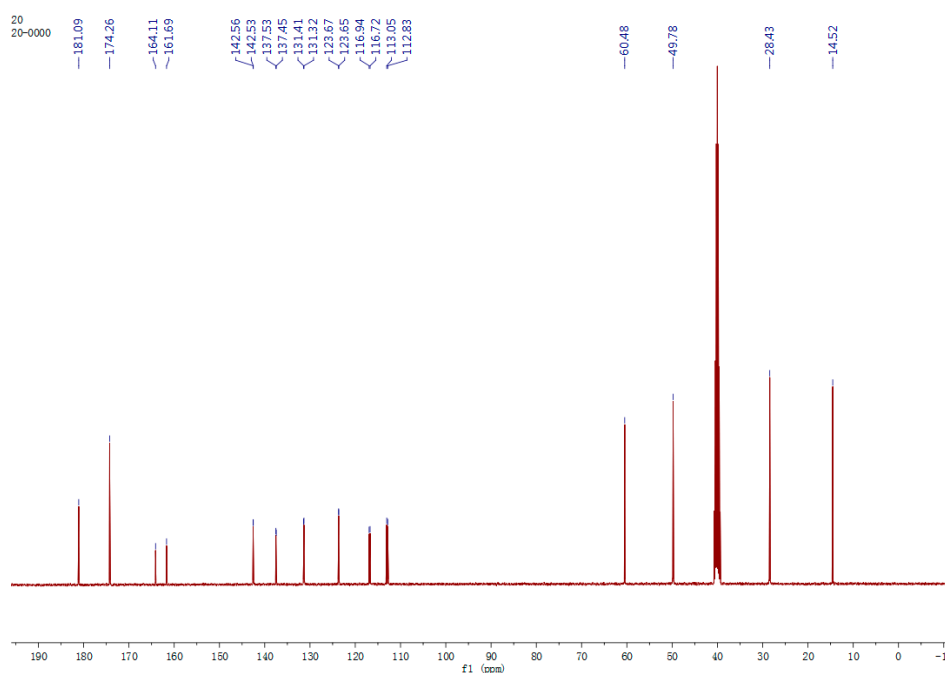


Figure S43. ^{13}C NMR spectra of the title compound **Ethyl (E)-1-(2-(3-fluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylate (3t)**

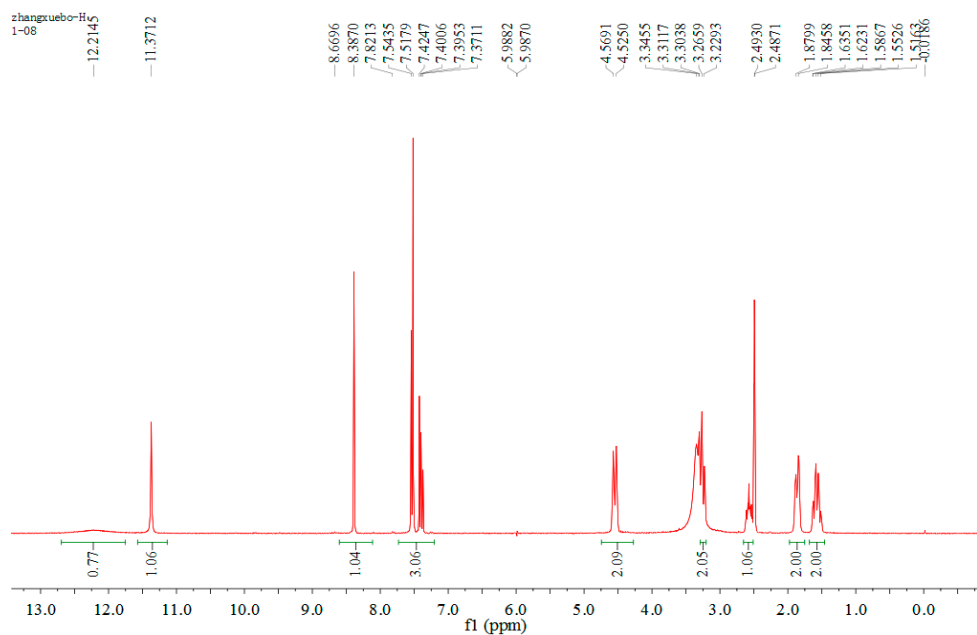


Figure S44. ^1H NMR spectra of the title compound
(*E*)-1-(2-(2,6-dichlorobenzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (**3u**)

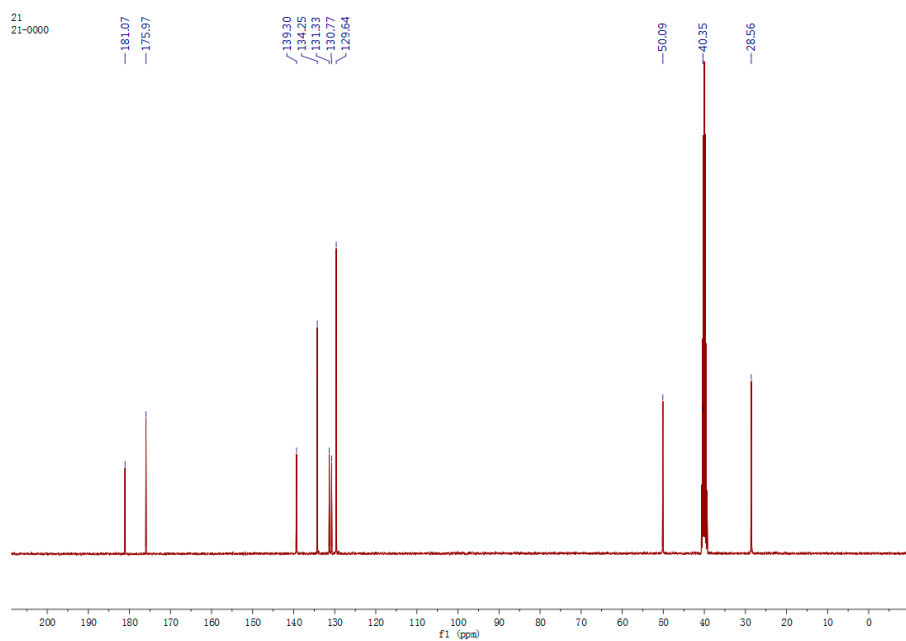


Figure S45. ^{13}C NMR spectra of the title compound
(*E*)-1-(2-(2,6-dichlorobenzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (**3u**)

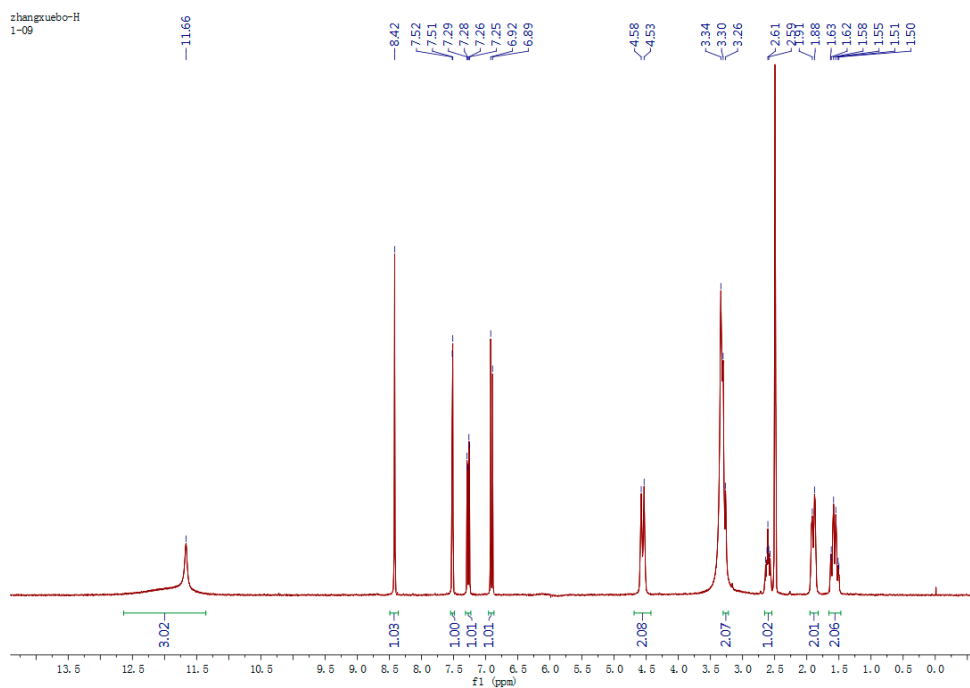


Figure S46. ^1H NMR spectra of the title compound
(*E*)-1-(2-(5-chloro-2-hydroxybenzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3v)

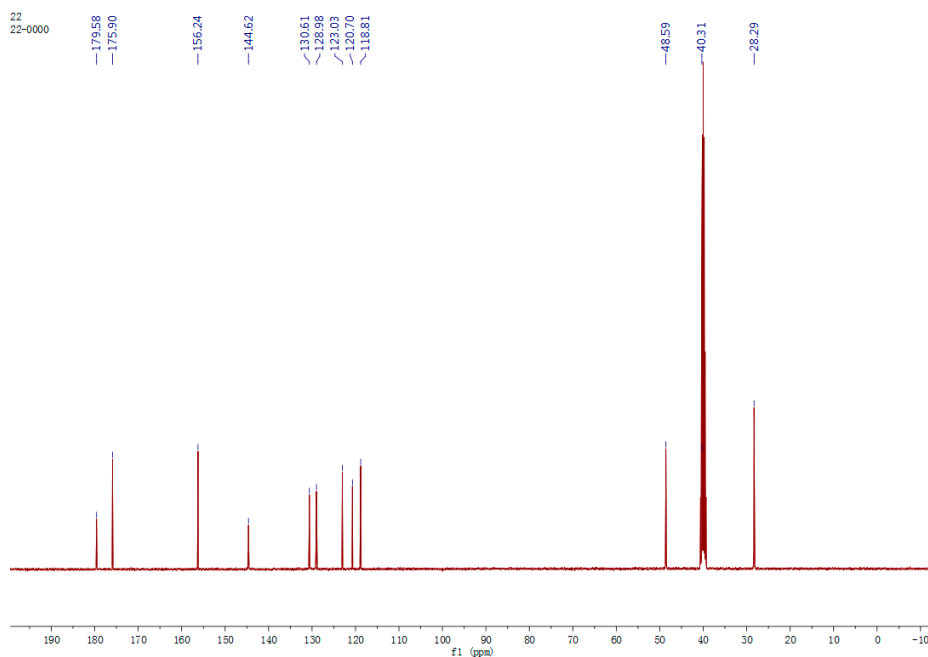


Figure S47. ^{13}C NMR spectra of the title compound
(*E*)-1-(2-(5-chloro-2-hydroxybenzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3v)

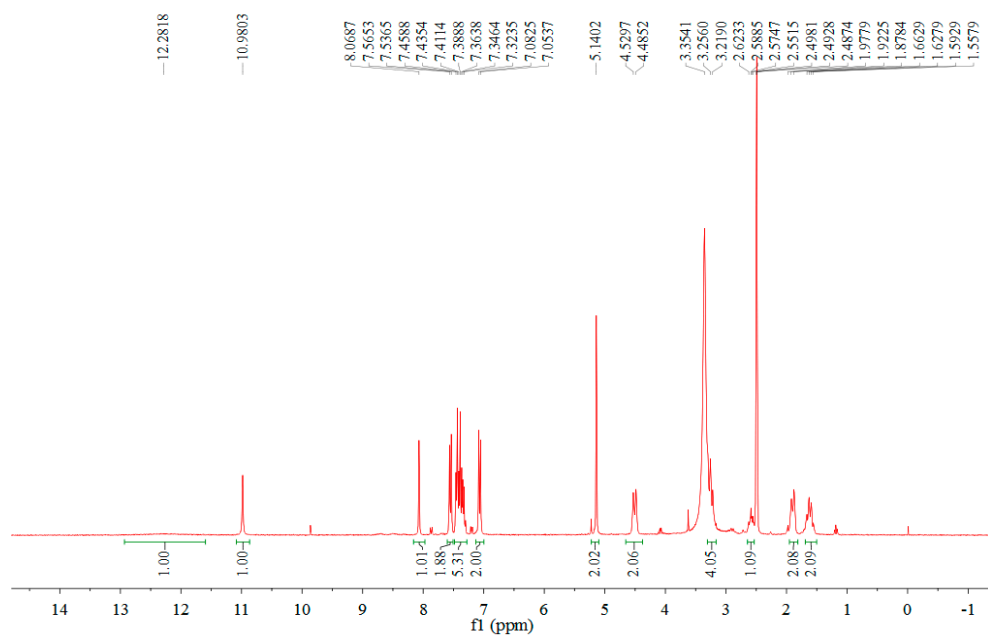


Figure S48. ¹H NMR spectra of the title compound
(*E*)-1-(2-(4-(benzyloxy)benzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3w)

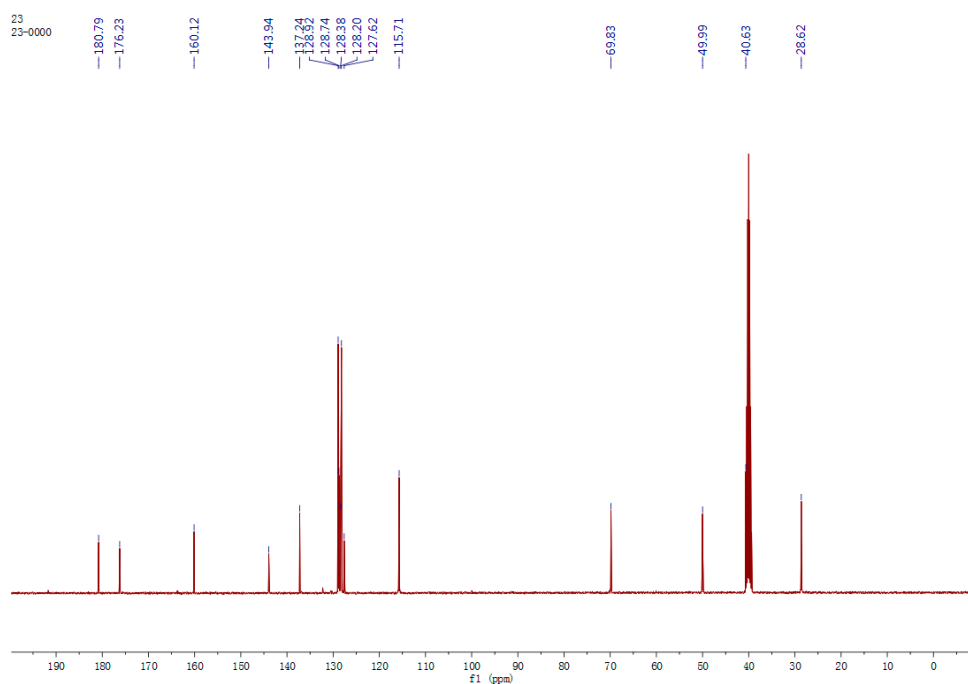


Figure S49. ¹³C NMR spectra of the title compound
(*E*)-1-(2-(4-(benzyloxy)benzylidene)
hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3w)

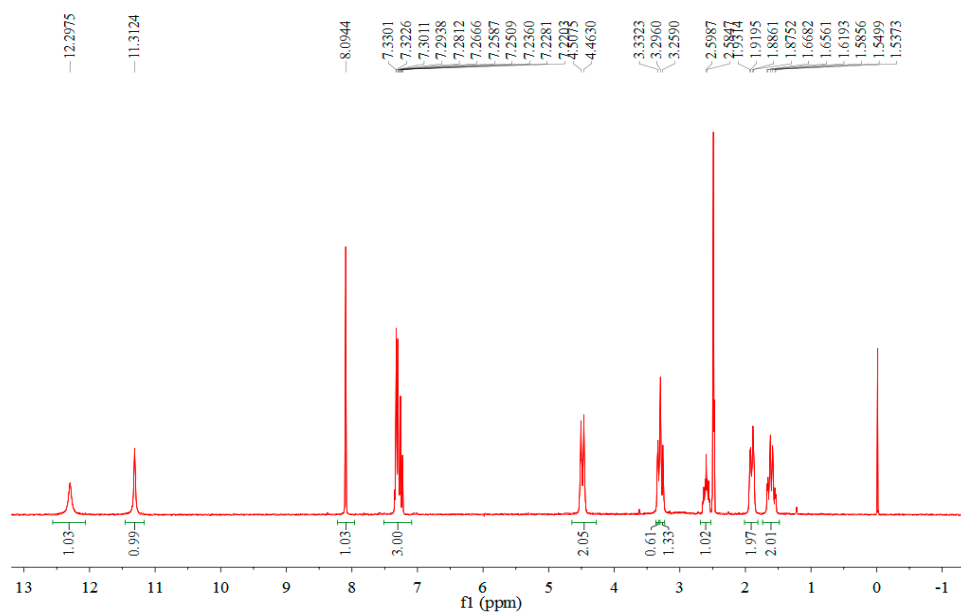


Figure S50. ^1H NMR spectra of the title compound
(*E*)-1-(2-(3,5-difluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3x)

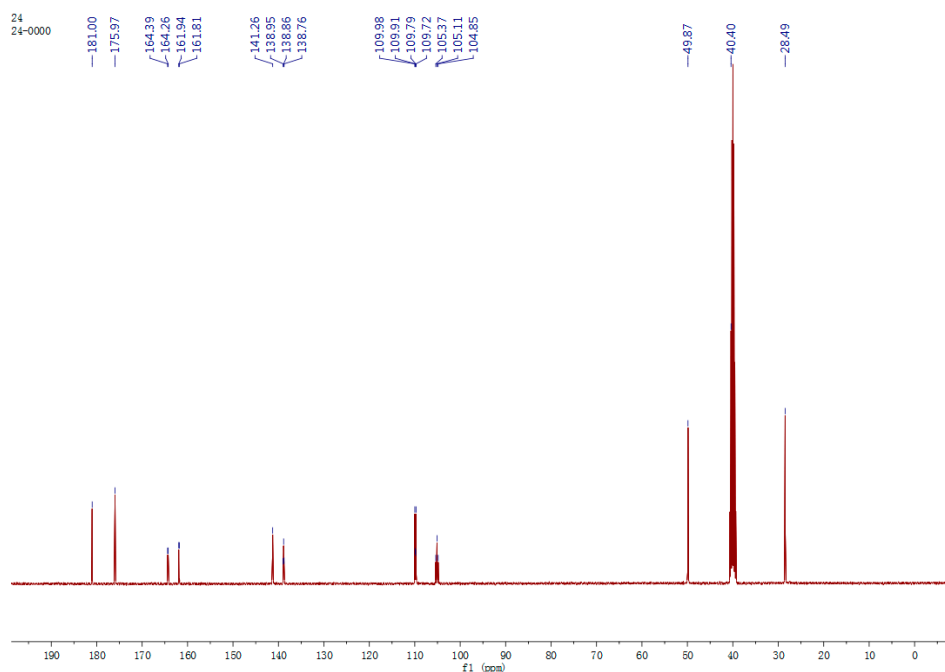


Figure S51. ^{13}C NMR spectra of the title compound
(*E*)-1-(2-(3,5-difluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3x)

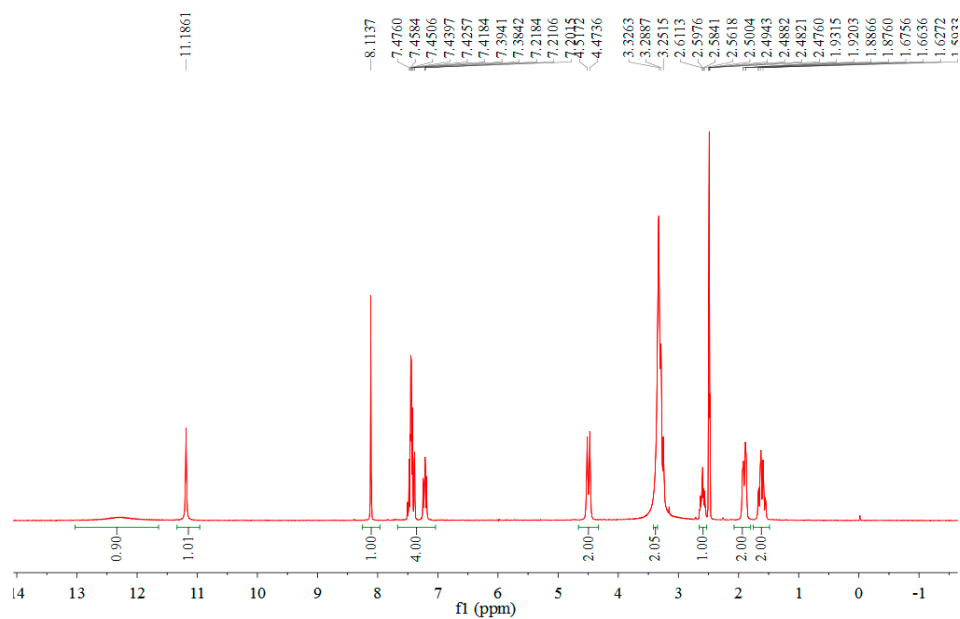


Figure S52. ¹H NMR spectra of the title compound (*E*)-1-(2-(3-fluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3y)

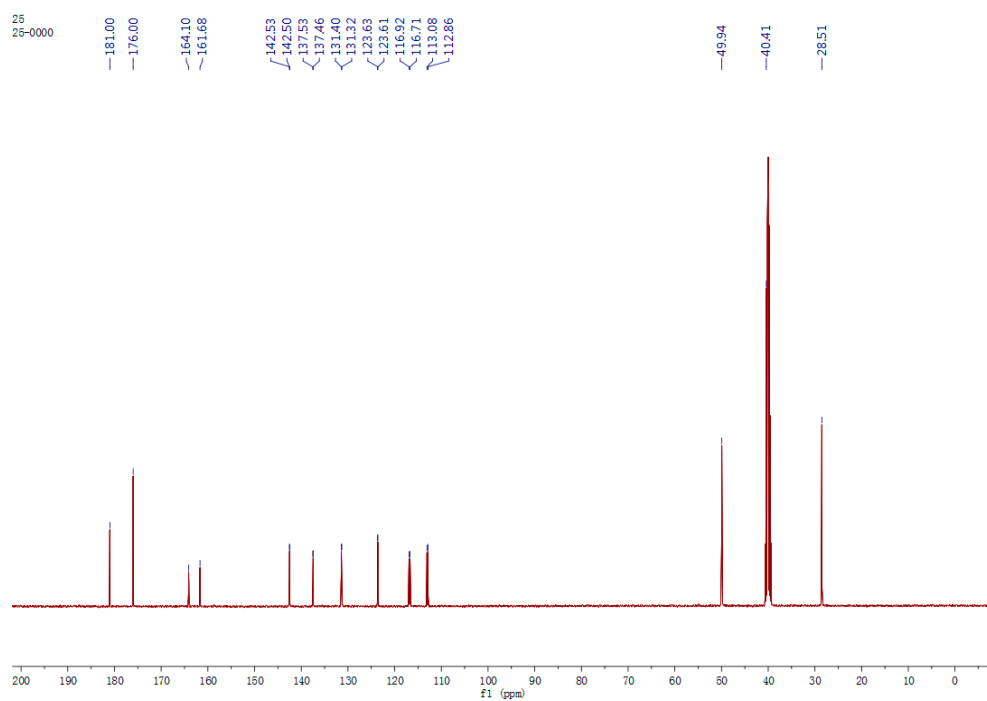


Figure S53. ¹³C NMR spectra of the title compound (*E*)-1-(2-(3-fluorobenzylidene)hydrazine-1-carbonothioyl)piperidine-4-carboxylic acid (3y)